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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled ....SURVEY OF THE LOCATION OF CHARCOAL AND CHARCOAL BRIQUETTE PLANTS IN NORTH AMERICA ......

....

submitted by ...Roger O. Lefrancois...........................

in partial fulfilment of the requirements for the degree of Master of ...Arts..................

THE UNIVERSITY OF ALBERTA

SURVEY OF THE LOCATION OF CHARCOAL AND CHARCOAL BRIQUETTE PLANTS IN NORTH AMERICA

BY

ROGER LEFRANCOIS

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

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EDMONTON, ALBERTA

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ABSTRACT

In this thesis the economics of the charcoal industry are examined. The British Columbia Research Council (hereafter referred to as B.C.R.C.) has developed a new process which utilizes wood wastes as a source of raw material. This is a continuous process capable of achieving significant economies of scale. Using this process, production costs are significantly lower than that achieved by other producers.

When considering market structure, it is necessary to identify two separate components of the industry. In the production of charcoal there are many very small firms which give it elements of monopolistic competition. There are also a few relatively large firms introducing elements of oligopoly. At this stage charcoal is largely an undifferentiated product. The briquetting of charcoal is oligopolistic with a differentiated end product being sold. In both production and briquetting there is evidence of price leadership.

Due to the competitiveness of the market and differentiated product resulting in brand name attachments, a new producer would have to take advantage of all the locational factors and minimize costs of production. In this manner he would be able to establish himself in a market area by selling his product at a lower price than his competitors.

There are many areas in North America that are at present deficient in charcoal production. If growth in consumption continues at the same rate, there will be much scope for the industry to expand in order to meet demand.

Many of the areas that are presently deficient are so to the extent of being able to support the entire output of a plant.

The locational characteristics are such that the two most important considerations are locating close to a good market area in order to minimize transportation costs and, due to high weight loss in the production process, locating close to an abundant source of raw material to minimize costs of production. There are several areas in North America that, meeting these two conditions, are favourable places in which to locate new plants.

There are very few Canadian producers and none serve a significant portion of the Canadian market. Due to low population densities, any market area is extensive and thus transportation costs are high. The more favourable areas are in the southern interior of British Columbia and in the southern part of Quebec and Ontario.

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CHAPTER I

INTRODUCTION

Nature and Scope

This thesis is an examination of the economics of producing charcoal and charcoal briquettes in North America. It is focused on the variables that affect the feasibility of putting new plants in production. Emphasis is placed on an analysis of the locational factors and the advantages that can be gained by locating in certain areas of North America. The rapid technological change embodied in the various methods of production is examined and comparisons are made in their costs of production.

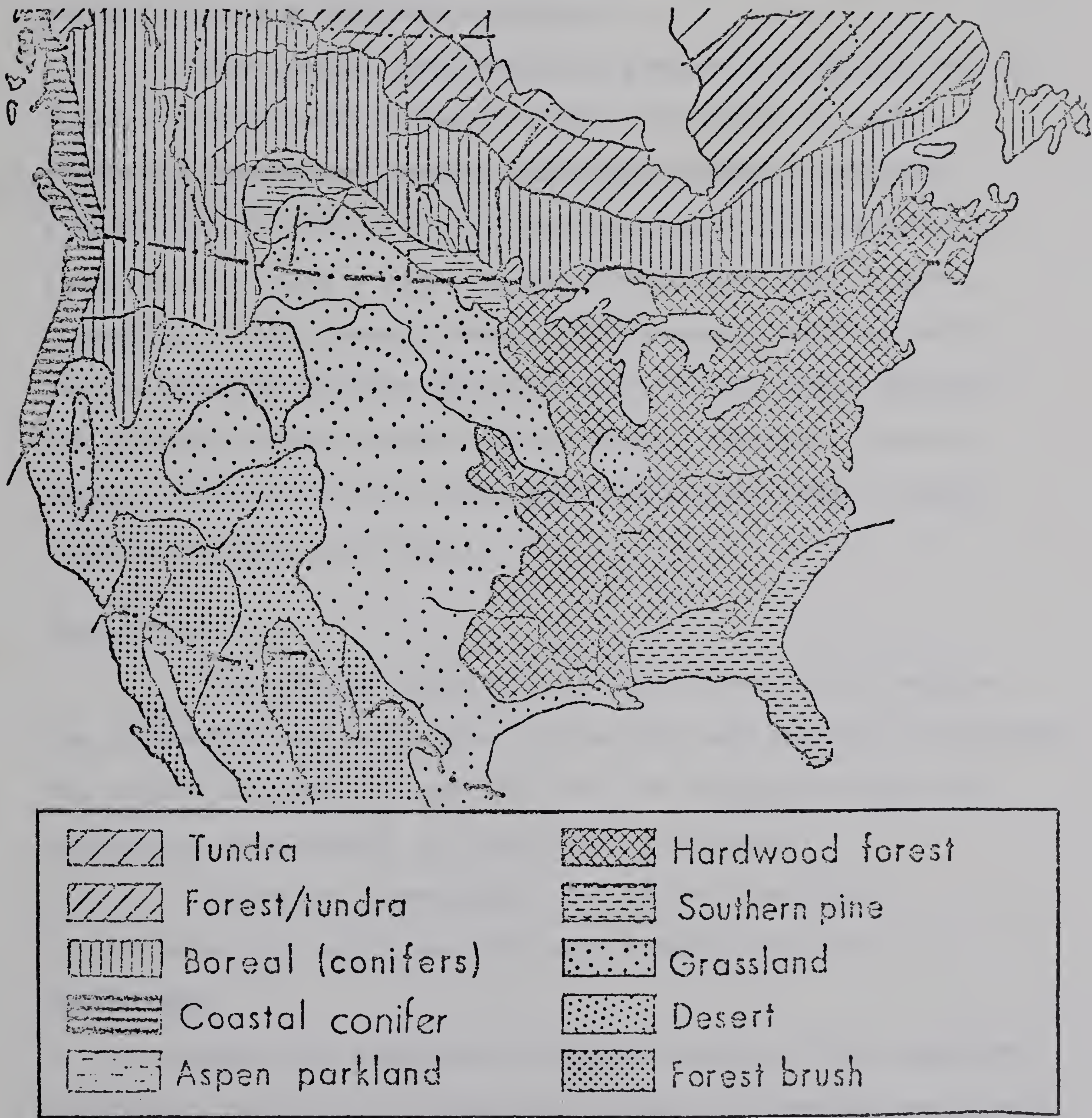
Certain parts of the North American continent have always been deficient in charcoal production. This is due to the fact that hardwoods have traditionally been used to manufacture charcoal and the hardwood forests, as illustrated in Figure 1, are concentrated on the east coast. Also due to higher population densities, plants locating on the east side of the continent had a large close market that served to minimize transportation costs.

Canada in particular has always been deficient in charcoal production. This may perhaps be due to the small size of the market, the large distances between major population centres, and as shown in Figure 1, a limited amount of hardwood forests.

New techniques of production have been developed

Figure 1

NORTH AMERICA BIOMES



Source: Alberta Department of Education, Renewable Natural Resources in Alberta, 1962, p. 10.

whereby charcoal can now be manufactured from mill wastes such as bark and sawdust of either hardwoods or softwoods. Several large manufacturers in North America are already using wood wastes as their primary raw material and their product is being sold and accepted.

Wood wastes from sawmills present a disposal problem. However these wastes become a source of profit if used to produce a marketable product such as charcoal. Since the weight loss is very high, in the conversion of wood waste to charcoal, it takes a large amount of waste to keep a plant operating. Only certain areas produce enough wood waste to keep a charcoal reactor going and only a very large sawmill can generate enough waste for one plant. However, several smaller mills in fairly close proximity could keep a large charcoal reactor operating.

Objectives

The overall objective of this thesis is to analyse the production and marketing of charcoal and charcoal briquettes. The nature and uses of charcoal will be examined along with historical development of production techniques.

There are essentially two major objectives:

1. To determine which are the more feasible methods of production;
2. To analyse the locational characteristics of the industry and select potentially favourable areas for locating new plants.

Methodology

Through an analysis of the costs of different methods of production, the least expensive method is selected. Particular emphasis is placed on an as yet untried method developed by the B.C.R.C. By historically tracing technological developments, the changes in the relative importance of different factors of production are identified.

In order to select potentially favourable plant locations, several factors have to be analysed. Demand for and supply of charcoal on a geographical basis have to be examined. This involves identifying the geographical distribution of quantities consumed and projecting consumption over the next few years. Supply is examined in terms of the location of present producers and quantities produced. The selling price in different areas of the United States and Canada and transportation costs are also looked at.

Different location theories and how they apply to the charcoal industry are examined. The factors that are then important in determining the location of new plants are identified. Combining areas that have an abundant source of raw material with areas that are deficient in charcoal production, determines potentially favourable plant locations.

Limitations

There are several limitations under which this thesis is written. First of all data sources on charcoal are very difficult to find. As a result, in certain sections, heavy reliance had to be placed on a very limited number of references.

Also the scope did not permit an analysis of all the locational factors. Only the more important ones are analysed and assumptions about the significance of the others are made.

In spite of the above mentioned difficulties, the conclusions drawn are deemed to be accurate based on the basis of best available information.

Format

The format basically follows the sequence outlined in the discussion of methodology. Chapter II examines the technical basis of charcoal production. In Chapter III the production in terms of where and in what quantities it is produced is analysed. Foreign trade in charcoal is looked at and also market areas in terms of total consumption. The chapters concludes with an analysis of marketing, geographical distribution of prices, and transportation costs. In Chapter IV breakdowns of the costs of production for the various production processes are outlined. Chapter V is a literature review of leading location theories. From this discussion, conclusions are drawn as to the locational characteristics that best fit the charcoal industry. Chapter VI, through an analysis of lumbering activity, determines areas that generate wood wastes sufficient to feed a charcoal reactor. All the important locational factors are tied together in this chapter and potentially favourable areas for locating new plants are identified. Chapter VII summarizes the study with emphasis on Canadian policy implications.

CHAPTER II

TECHNICAL BASIS OF CHARCOAL PRODUCTION

The Nature of Charcoal

Manufacturing charcoal is an ancient art, practiced in many parts of the world. It has been practiced in North America since early colonial days.[1]

The manufacturing of charcoal is basically a simple process. Any cellulosic material such as wood, shells, fruit pits, garbage, etc., is placed in a chamber in which the supply of air is limited. The material is then heated beyond its ignition temperature and thermal decomposition takes place.

Typically, charcoal has the following general composition:[2]

fixed carbon	75-90%
volatiles	5-28%
ash	0.5- 3%
moisture	2- 5%

During thermal decomposition of woody materials, a wide variety of gases and liquids are formed. These are combustible and may be used in the heating process.

---

[1] F. E. Hampf, The Production and Sale of Charcoal in the Northeast, (Washington: U.S. Department of Agriculture, Forest Service Division, 1957).

[2] M. V. Green, The Charcoal Industry in Ontario, (Ontario: Department of Field Service, Ontario Research Foundation, 1961).

Effect of Process Conditions on Charcoal[3/]

The quality, yield, and production rate of charcoal from any process depend markedly on processing conditions, wood species, and condition of raw material.

a) Wood Species:

Hardwoods have been favoured for the production of charcoal. The reason has been largely prejudice although dense hardwoods tend to give slightly higher percentage yields of charcoal and greater production from a given kiln than do softwoods.

Charcoal percentage yield is principally a matter of the amount of carbon in the wood. Most woods contain about 50 percent carbon, about half of which is lost in liquid and gaseous products. Since most commercial charcoals contain about 80 percent fixed carbon, typical good charcoal yields range from 20 to 35 percent of the weight of the raw material.

Different wood species yield different percentages of charcoal. However, the percentage difference is not as significant between species as it is between dense hardwoods and softwoods.

b) Moisture Content:

There appears to be little effect of moisture on charcoal yield in indirectly heated kilns. The production

---

[3/] The following two sections are based on: British Columbia Research Council, The Charcoal Industry, (Vancouver: British Columbia Research Council, 1966).

rate of charcoal, however, is markedly reduced by the time required for the water to evaporate, and the heat requirements are also increased. In direct fired kilns where carbonization is initiated by controlled combustion at the beginning of the process, percentage yield and production capacity are both decreased by moisture.

Generally wood is predried for carbonization. Round wood is usually air seasoned and fine wood is dried in rotary kilns. Most continuous units are sensitive to moisture content and can only operate effectively on dry material.

c) Time and Temperature:

Charcoal yield decreases with increasing temperatures used in carbonization. Most batch processes operate in the range 800 F. to 950 F. with carbonization time about 24 hours. Continuous processes usually operate at higher temperatures with shorter reaction times. The volatile content is also lower the longer the retention time or the higher the temperature.

d) Feed Size:

Under carefully controlled temperature conditions, the same charcoal yield can be obtained from fine and coarse feed. In older batch kilns with poor temperature control, fine feed could be overheated with a consequent loss in yield. In continuous reactors the careful control of temperature ensures that such overheating will not occur. Fine wood particles are not suited to batch operations because it is difficult to obtain uniform heat distribution in such masses.

Types of Carbonization Equipment

There are basically two types of processes used in the production of charcoal. This section will first examine the characteristics of each process and then look at some of the different methods of production in each process.

a) Batch Processes:

Traditional methods have utilized batch equipment. Even today a major portion of charcoal is still made in batch processes. There have been some modifications of batch processes which have resulted in semi-continuous operations. Some of the new plants today use large batch units more amenable to mechanization than the older small units.

In batch operations the kiln is filled with wood, some of the charge is burned or hot gases are circulated through it to begin carbonization. The charge is then cooled in the kiln and the charcoal withdrawn. The length of the cycle may vary greatly from three to fourteen days depending on the size and type of kiln used.

The feed material employed is usually round wood or slabs. The operation works best with seasoned or predried feed.

The principle advantages are:

1. Low capital cost per unit of production.
2. Simple operation.
3. Can be portable.

The principle disadvantages are:

1. High labour requirements.
2. High maintenance.

3. Suitable only for large wood which usually is expensive feed material.
4. Difficulty in keeping the quality of the charcoal uniform.
5. Output capacity generally lower than continuous processes.

b) Continuous Processes:

These processes have been developed mainly to utilize cheap fine wood wastes and to reduce labour costs. They operate at higher temperatures, minimize the time of carbonization and increase production rate over batch processes. Since their capital cost is much higher, their production rates must be higher also.

The principle advantages are:

1. Can handle smaller material. Since this is usually wood waste, it is cheap material.
2. Labour costs are low.
3. Product uniformity can be controlled.

The principle disadvantages are:

1. High capital investment per unit of production. However, this no longer holds for some of the newer processes.
2. Usually not as simple to operate as batch processes.
3. Usually not portable as they are large.

c) Types of Batch Processes:

i) Earth Pit Kilns - These are the oldest forms of kilns. In this process round wood is stacked into a conical shape, covered with earth, and carbonization is initiated by controlled combustion at the bottom of the stack. The volatiles escape through vent holes.

The capital investment required is very low; however, labour costs are high and the production rate is low. Although no estimates of production cost are available, they are likely in the order of \$60 to \$70 per ton. Double that of the more modern continuous processes.

ii) Concrete Block Kilns - Basically a simple rectangular building made from concrete masonary units with a large door at one end. It has a stack to vent gages and controllable air flues around its periphery to admit adequate air to initiate carbonization.

Kiln sizes usually range from 2 to 10 cords capacity with construction costs varying from \$100 to \$200 per cord of capacity. Maintenance is continuous and the kiln likely has to be rebuilt after approximately 200 runs. Using preseasoned or dry wood, a complete cycle will take 3 to 4 days in a smaller kiln and longer in a larger one.

The U.S. Department of Agriculture estimates of production costs, exclusive of raw material and maintenance, are shown in Table 1. If we calculated in a raw material cost of \$10.00 per cord with one cord yielding less than one ton and added maintenance charges, the cost per ton might easily double the given \$27.44 figure.

iii) Metal Kilns - Some of the smaller kilns are made completely from sheet metal or from a masonry body with a metal roof. Made out of metal, they are usually portable and consequently must be light enough to be transported easily. Their capacity is about one to two cords. Construction costs

Table 1

CONCRETE BLOCK KILN - COST PER TON
(excluding Raw Material and Maintenance, 30 percent yield)

Item	Cost Per Ton ($)
Kiln construction and depreciation	$ 8.83
Loading	7.41
Door closure	3.60
Firing control and sealing	5.59
Kiln discharge and truck loading	2.01
	$27.44

are about twice as high per unit capacity as the concrete masonry kilns.

Production costs are higher than in masonry kilns because kiln capacity is less and also they are poorly insulated resulting in lower yields. However, where labour is cheap and timber scattered, they can be used effectively to make use of off-season labour with minimum capital investment.

iv) Beehive Kilns - Made of brick and concrete, they are generally much larger than the metal kilns described above. These have been in popular use for many years. Some of the more recent ones have included modifications of the old designs to enable mechanization.

The capacity of these kilns range from 50 to 90 cords. Wood is charged through a hole in the ceiling and the charcoal discharged through a side door.

The cycle length is about 20 to 30 days and the yield is about 700 pounds per cord of seasoned wood. Production

costs are largely dependent on raw material cost, as with large volume production and mechanization labour, costs can be substantially reduced. Estimated cost of production is $45 to $55 per ton. Capital investment is from $100 to $150 per cord of capacity.

v) Brick and Ceramic Kilns - In many areas, kilns, formerly used for the manufacture of brick and other ceramic products, have been abandoned. These kilns, with minor modifications, are well suited to charcoal production. They are well able to withstand repeated high temperature cycling without damage.

vi) Oven Processing Kilns - These are more commonly used in the hardwood distillation industry where charcoal and liquid products are both recovered.

The oven, having a capacity of about ten cords of cordwood or short block lengths, is made from sheet steel or brick and concrete. The wood is placed in kiln cars which run on steel rails on the oven floor in line with yard and charcoal cooler tracks to permit simultaneous charging and discharging.

Carbonization time is 18 to 22 hours at 800 F. The charcoal is then cooled for 48 hours in an air-tight sheet metal cooler. The yield is 1,000 to 1,100 pounds per cord for heavier hardwoods. Capital investment is approximately $35,000 per cord capacity and an output of 100 cords daily is necessary for profitable operation. This corresponds to 50 tons per day of charcoal from a 3.5 million dollar installation.

vii) Reichert Process - This process was developed to use cheap wood and reduce labour costs. It uses dry or green wood and can be operated batchwise or continuously. Hot gas passing through the charge initiates carbonization. Rotary valves at the top and bottom permit the charging of wood and discharging of charcoal without air entry.

viii) Small Vertical Steel Retorts - These are used for carbonizing chunk or short length wood. 9,000 pounds of feed is carbonized for 7 to 8 hours at 700 F. to 900 F. Charcoal production is 2.5 tons per 25 hours for an investment cost of $15,000 for the retort only. Heat is supplied by an oil burner.

d) Types of Continuous Processes:

i) Stafford Retort - A large cylindrical vertical retort, 10 feet by 40 feet, is fed predried wood chips or small blocks from the top. The wood is pre-heated to 300 F. to provide initial heat for carbonization. As the wood moves down the reactor, carbonization occurs and the temperature rises to a maximum of 950 F. It then falls to 480 F. at the outlet. Yields are about 1,000 pounds per cord.

Neither capital costs nor production costs for this process are available as existing installations are so old that it is difficult to obtain reliable cost data for them.

This retort was built originally for the hardwood by-product industry and has consequently been confined to plants with large capacity. It has not been used in smaller plants, possibly because of its high capital cost.

Two other processes, Lambiotte and Reichert, are similar except that heat is provided by hot gases circulating through the charge. These gases may be recycled wood gas or from another fuel.

Labour requirements in these processes are rather low, therefore production costs depend largely on the cost of raw material. They are estimated to be less than $20.00 per ton.

ii) The Lantz Converter - This process is in operation at a number of places. It is a rotary kiln indirectly heated by gases evolved during carbonization. This unit is highly automated and has equipment available for recovery of tars, oils, etc.

Yield is about 25 percent of dry wood weight with one converter handling two tons per hour of dry wood. One converter costs between $75,000 and $100,000. Costs of production may vary significantly depending on such factors as: number of converters in the plant; length of depreciation; cost of raw material, and personnel.

iii) Screw Conveyor Process - Two installations of this type have been made in South Carolina. At one of them, pre-dried shavings and sawdust are fed to 13 horizontal tubes each 13 inches in diameter and 40 feet long. The tubes are heated externally by recycled wood gas and the feed is moved through the tubes by continuous screws. The plant supposedly uses about 120 tons per day of dry material and employs 25 people. Its output should be about 40 tons per day of charcoal.

Although no production or capital costs are available for this process, the description indicates it is not simple. Therefore capital costs are likely high and, being so labour intensive, production costs must also be fairly high.

iv) Nichols Carbonizer - This is a continuous process that uses wood waste for raw material. This process uses a multi-hearth furnace. It is presently the process in use at several plants. Production costs are in the neighbourhood of $20 to $25 per ton.

v) Vertical Retort - A company operated for a limited time, a rectangular multi-compartment vertical retort similar to a coke oven. This unit was fed green sawdust and initially heated by natural gas until wood gas could later be recycled to provide heat.

This unit was unique in being the only continuous vertical retort capable of handling green sawdust with indirect heating. Normally heat transfer is so poor through fine wood that a direct heated, agitated type of reactor is required.

Estimates for plant cost are not accurate and the plant was not operated long enough to establish production costs.

vi) Fluid Bed Processes - In these reactors, solid particles are suspended in an upward stream of gas, the gas and solids act as a homogeneous fluid with properties distinct from either of its components. The British Columbia Research Council, in patenting a process, used this type of a reactor to carbonize fine wood waste. Since it is the most modern

process today it will be looked at separately in the following section. Charcoal is withdrawn continuously through overflow pipes and gases with charcoal fines are withdrawn overhead. At 850 F. small dry particles are carbonized in less than 15 minutes so that production rate is a function of fluid-bed depth and feed rate.

e) British Columbia Research Council Charcoal Process:

The following is taken directly from an unpublished B.C.R.C. paper describing the process they developed and patented.

PROCESS DESCRIPTION

Feed Material

The process will utilize any kind of wood or bark as long as it is in relatively fine form. Material similar to sawdust is preferred although planer shavings and groover dust have been used successfully. Fibrous materials should be hogged to produce a roughly cubical particle shape. Moisture contents as high as 100 percent (dry basis) are acceptable, although better yields and smoother operation are achieved at lower moisture levels.

Type of Operation

The carbonization is carried out in a fluid bed reactor where the exothermic heat of wood decomposition is supplemented by controlled combustion to provide all heat requirements. When the reactor is operating a portion of the wood gas driven off is recycled to an external furnace to supply hot, inert fluidizing gases. No external source of heat is required.

Sawdust* is fed continuously to the reactor and charcoal is withdrawn continuously through overflow pipes and from an overhead cyclone. Crude wood gas is withdrawn overhead through a cyclone, and oils, tars, etc. may be removed before the gas is recycled or used for other heating duties. Because the process is continuous, all products are of constant quality.

*Sawdust is used to describe all fine wood material.

The reactor is extremely simple, being constructed from light-gauge stainless steel with external thermal insulation. One reactor, 5 feet diameter by 10 feet high will produce from 3 to 4 tons of charcoal per 8-hour shift. Two operators can handle two such units.

Product

The charcoal yield is about 23 percent of the dry weight. The nature of the product can be varied widely by changing the carbonizing time and temperature. The charcoal is in the form of fine particles similar to the sawdust fed but with a higher percentage of very fine material.

ADVANTAGES OF PROCESS

1. It makes use of feed material which has little or no value, the cost of production is thus reduced and the end product made very competitive.

2. The process can be controlled very accurately to yield any desired product.

3. The equipment can be used for making activated charcoal from ordinary charcoal.

4. Since the process is continuous, constant quality of all products results. The gas produced can be used for heating without storage because its heating value does not change with time.

5. The reactor can be shut down and started up very rapidly, lending itself to shift operation.

CHAPTER III

PRODUCTION, CONSUMPTION, AND MARKETING OF CHARCOAL

The Nature of the Charcoal Market

Charcoal production in North America dates back to early colonial days. Initially charcoal exclusively served the industrial market. At first it was used as a fuel to smelt iron. As better fuels developed to serve this use charcoal became used as a cheap fuel for heating and cooking.

Along with the advent of large urban and metropolitan areas, came a new use for charcoal. In the form of a briquette, charcoal became popular as a luxury fuel for the outdoor barbecue, and was soon to dominate the market. A survey of charcoal producers in the U.S., carried out by the U.S. Forest Service in the early 1960's, showed a decline in shipments to industrial users from 47 percent in 1956 to 18 percent in 1961.[1/] Domestic use of charcoal raised prices to such an extent that it no longer was economical for most industrial users. Today approximately 5 percent of charcoal produced serves the industrial market.

The growth in demand for charcoal as a cook-out fuel has grown very rapidly. The reasons for this growth have been rising incomes, increase in leisure time, and a growing interest in outdoor recreation.

1/ British Columbia Research Council, The Charcoal Industry, p. 4.

Charcoal Producers

In 1961 there were 1,977 converting units in charcoal plants in the United States.[2] Many of these were very small using old and, by today's standards, uneconomical means of producing charcoal. Over 90 percent of these were in the east. Figure 2 taken from a study done in 1961 gives the U.S. geographical locations of some of the plants.

In 1961 there were 50 charcoal briquette plants in the U.S. They produced about 235,640 tons per year and, in keeping with the location of the converting units, they were mainly situated in the east.[3]

It is believed that the number of charcoal converting units now in operation has been reduced substantially. At present there are 11 charcoal plants with carbonization furnaces in the U.S. and one in Canada. The 11 in the U.S. have a total production capacity of 140,000 to 180,000 tons per year or about one third of the total output. Figure 3 gives the locations of the 11 U.S. plants, as indicated nine are old and two are modern. Table 2 gives company names and addresses of these plants. These plants are generally located where there is an abundance of wood residues in keeping with the shift of use of wood wastes from round wood.

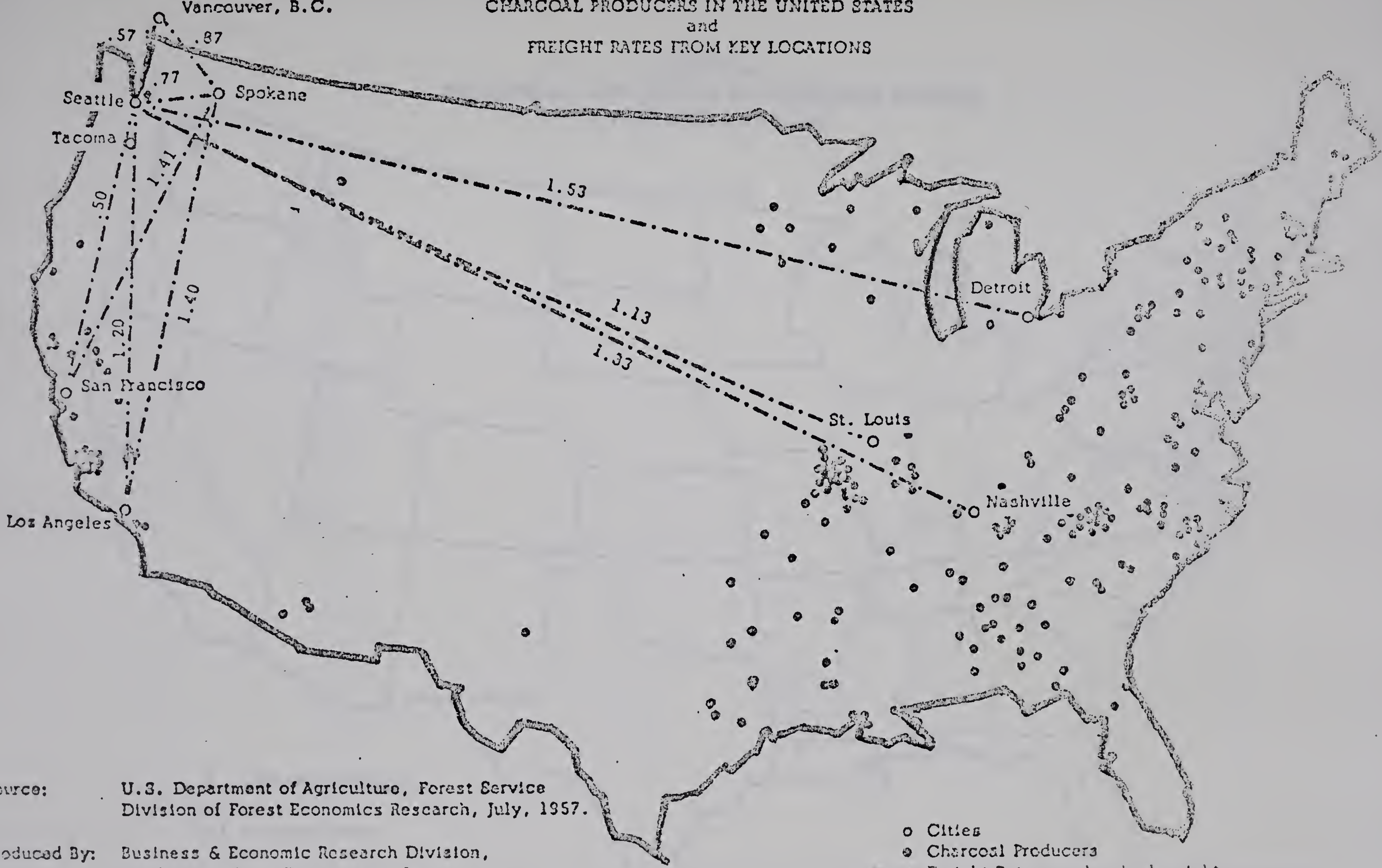
---

[2] T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, (Atlanta, Georgia: Georgia Institute of Technology, 1971), p. 8.

[3] Ibid., p. 8.

Figure 2

CHARCOAL PRODUCERS IN THE UNITED STATES
and
FREIGHT RATES FROM KEY LOCATIONS

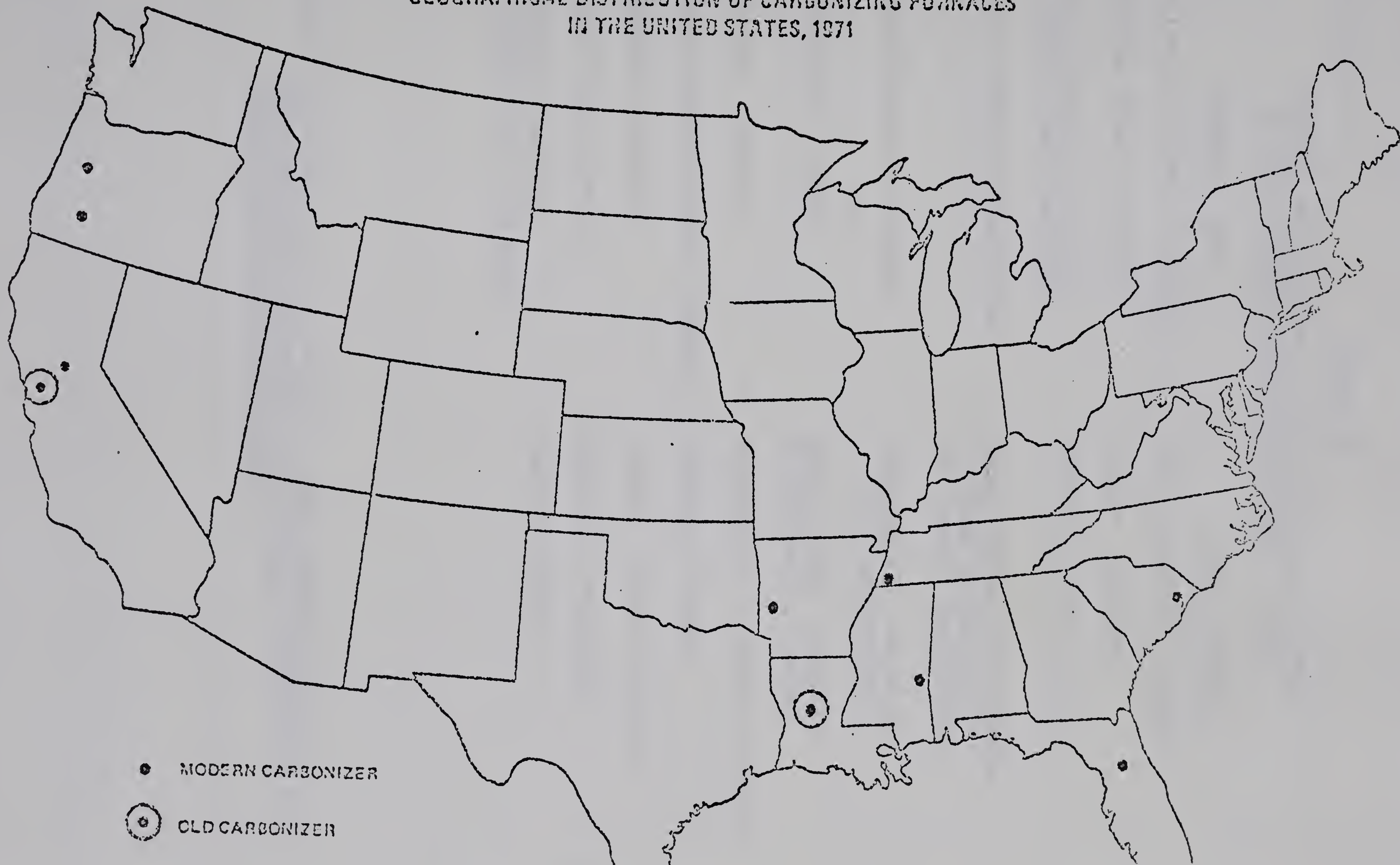


Source: U.S. Department of Agriculture, Forest Service Division of Forest Economics Research, July, 1957.

Produced By: Business & Economic Research Division, Washington State Department of Commerce & Economic Development.

Figure 3

GEOGRAPHICAL DISTRIBUTION OF CARBONIZING FURNACES IN THE UNITED STATES, 1971



Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 9.

Table 2

MODERN FURNACE OR RETORT CHARCOAL PLANTS IN THE UNITED STATES AND CANADA, 1971

Company Name	Plant Address
Atlantic Forest Products	New Brunswick, Canada
Dierks Forest Products	Dierks, Arkansas
Hood Charcoal Company (Dizzy Dean Company)	Pachuta, Mississippi
C. B. Hobbs Corporation	Santa Clara, California - (old carbonizer) Elk Grove, California
Home Charcoal Company	Alexandria, Louisiana - (old carbonizer)
Kingsford Company	Beryl, West Virginia Springfield, Oregon
Muskoka Charcoal	Huntsville, Ontario, Canada
Olsen-Lawyer Lumber Company	Medford, Oregon
Ragsdale Company	Conway, South Carolina
Royal Oak Charcoal	Memphis, Tennessee
Pioneer Charcoal (Timberland Products)	Ocala, Florida

Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 43.

Briquetting[4]

There are 23 companies operating 33 briquetting plants in the United States, marketing under about 100 trade names. In addition there is one plant in New Brunswick, Canada. The U.S. plants produced about 500,000 tons of charcoal briquettes in 1970, absorbing nearly all of the charcoal produced. Total combined capacity of the 33 United States plants plus the one in Canada, and one in each of Mexico and Ecuador was 111 tons per hour. Operated on a 24 hour day, 50 weeks per year gives a yearly capacity of over a million tons. Therefore at present, there is excess capacity in briquette manufacturing.

Briquette plants are generally located near or adjacent to charcoal converting units, in order to minimize transportation costs. Figure 4 gives the production capacities and geographical distribution of the 33 United States plants. Table 3 gives the company names and addresses and plant locations. Most briquette producers produce at least part of the charcoal required for their operation with some buying charcoal from outside to supplement their own production.

Total Production

Statistics on charcoal production are difficult to obtain due to the fact that there are so many charcoal producers.

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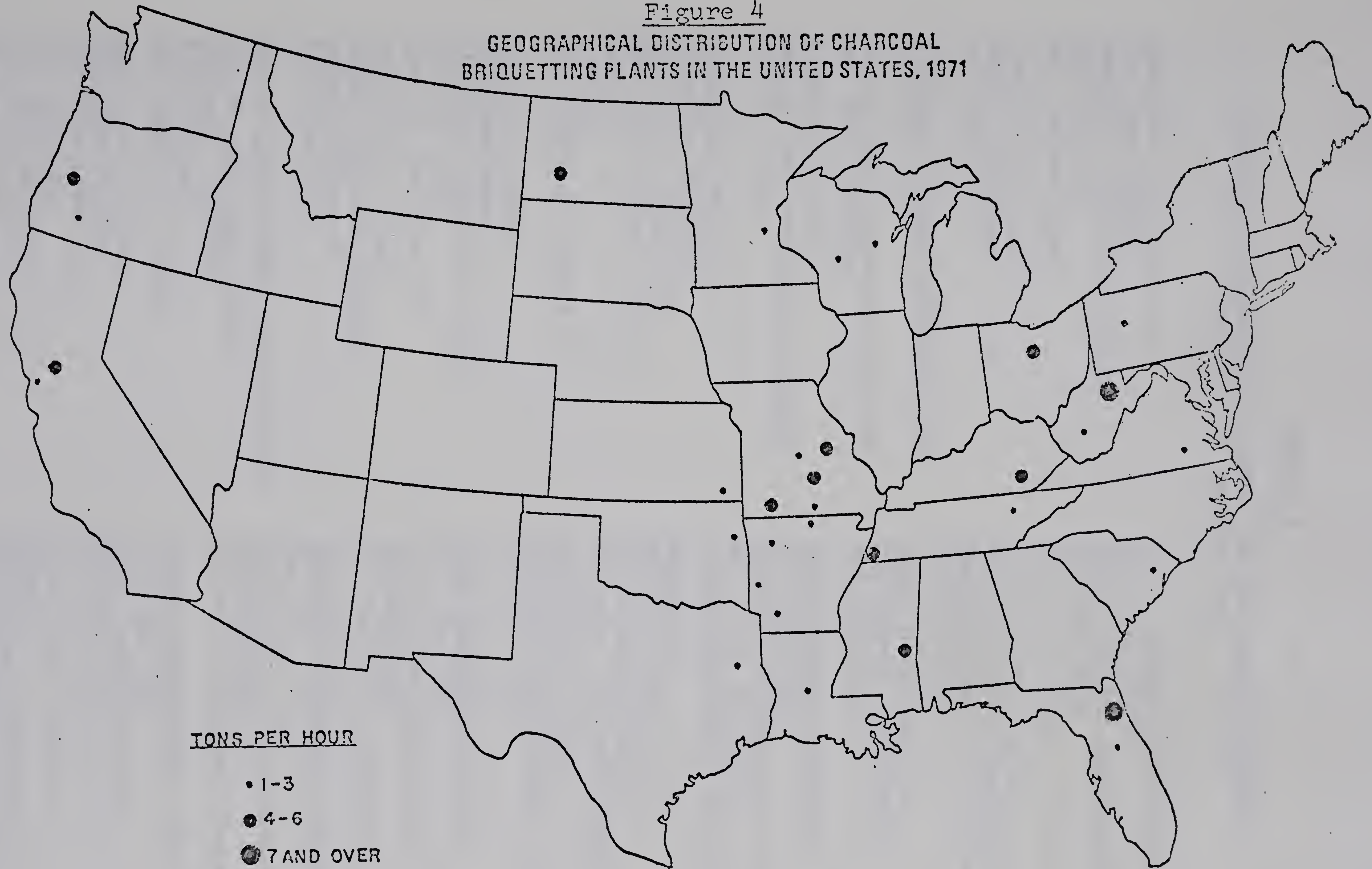
[4] T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, pp. 9-13.

Figure 4

GEOGRAPHICAL DISTRIBUTION OF CHARCOAL BRIQUETTING PLANTS IN THE UNITED STATES, 1971



Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 42.

Table 3

CHARCOAL BRIQUETTING PLANTS IN THE UNITED STATES, CANADA, AND MEXICO, 1971

ARKANSAS CHARCOAL CO.
P.O. Box 12450
Memphis, Tennessee 38112
901/324-5516
Mr. Andrew Sigel

Production Plant:
Paris, Arkansas
501/963-2030

ATLANTIC FOREST PRODUCTS LTD.
P.O. Box 129
Minto, New Brunswick, Canada
Mr. Dave Jackson

Production Plant:
Minto, New Brunswick, Canada
506/327-3311

BRIQUETAS MEXICO,
Sociedad Anonima
Apartado Postal 684
San Luis Potosi, S.L.P.,
Mexico
2-77-02
Ing. Luis O. Ibanez S.

CUPPLES COMPANY
7800 Bonhomme
Clayton, Missouri 63105
314/725-6154
John K. Wallace, Jr.

Production Plant:
Floyd Charcoal Company
Salem, Missouri
314/729-4134

GREAT LAKES CARBON CORPORATION
333 N. Michigan Avenue
Chicago, Illinois
312/372-5445
Mr. Lowell E. Wills

Executive Office:
299 Park Avenue
New York, New York
212/935-2400
Mr. Milton Kaplan

Production Plant:
Marion, Ohio

C. B. HOBBS CORPORATION
P.O. Box 180A
Santa Clara, California 95052
408/262-3550
Mr. C. B. Hobbs, President

Production Plants:
Foot of Dixon Landing Road
Santa Clara, California
408/262-3550

10000 Waterman Road
Elk Grove, California
916/685-3925

HOOD CHARCOAL COMPANY
P.O. Box 4875
Jackson, Mississippi 39216
Mr. L. M. Ferrell,
Vice President, General Manager

Owned by:
Masonite Corporation
29 N. Wacker Drive
Chicago, Illinois 60606

Production Plant:
Pachuta, Mississippi 39347
601/776-2171

HOME CHARCOAL COMPANY, INC.
P.O. Box 814
Alexandria, Louisiana 71301
318/442-5757
Mr. Walter J. Redmond, President

HUMPHREY CHARCOAL CORPORATION
Box 45
Brookville, Pennsylvania 15417
814/V19-2302
Mr. R. C. Humphry, President

HUSKY BRIQUETTING, INC.
P.O. Box 380
Cody, Wyoming 82414
307/587-4711

Production Plants:
Drawer 1
Dickinson, North Dakota
701/225-6023

Table 3 (continued)

Route 2
Hixton, Wisconsin
715/963-2172

Box 2670
Isanti, Minnesota
612/724-5573

Box 308
Waupaca, Wisconsin
715/258-3281

Muskoka Charcoal Company
P.O. Box 1030
Huntsville, Ontario, Canada
705/789-5583

IMPERIAL BRIQUET CORPORATION
Kenbridge, Virginia 23944
703/676-8238
Mr. A. R. Mahaney, President

JAYHAWK CHARCOAL COMPANY
Chetopa, Kansas 67336
316/BE6-7256
Mr. "Red" Webster

KEETER CHARCOAL COMPANY
Branson, Missouri 65616
417/334-4195
Mr. James P. Keeter, Manager

Production Plant:
Branson, Missouri 65616
417/334-4888

KINGSFORD COMPANY
Box 1033
Louisville, Kentucky
502/582-2801
Mr. Owen Pyle, President
Mr. Jim Greanias
Mr. Walt Umenhofer

Production Plants:
P.O. Box "B"
Springfield, Oregon
503/746-9601

Belle, Missouri
314/859-3321

P.O. Box "K"
Parsons, West Virginia
304/478-2911

Cumberland Corporation
Burnside Kentucky

OLD HICKORY CHARCOAL, INC.
Mountain View, Missouri 65548
417/934-2291
Mr. V. Smith, President

PINE-O-PINE CO., INC.
523 W. 22nd
Box 7325
Houston, Texas 77008
713/864-7977
Mr. Lawrence Lynn

Production Plants:
Char-Time Charcoal Division
Box 1167
Jacksonville, Texas 75766
214/586-3081
Mr. J. C. Swanson, Jr.

Char-Time Charcoal Division
Box 547
Lewisville, Arkansas 71845
501/921-4994
Mr. Herb Morgan

PIONEER CHARCOAL COMPANY
Box 1799
Ocala, Florida 32670
904/629-0005
Mr. Joe Crace
Mr. Don Crace

T. S. RAGSDALE COMPANY, INC.
P.O. Box 937
Lake City, South Carolina 29560
803/394-8567
Mr. T. S. Ragsdale, Jr.,
Vice President

Production Plant:
Conway, South Carolina

ROSEVILLE CHARCOAL & MANUFACTURING
COMPANY
P.O. Box 1188
Zanesville, Ohio 43701
614/452-5473
Mr. Ray E. Longstreth, President

Production Plant:
Bentree, West Virginia

Table 3 (continued)

ROYAL OAK CHARCOAL COMPANY
P.O. Box 38
Memphis, Tennessee 38101
901/525-4391
Mr. T. C. Clarkson,
Vice President, Marketing

Production Plants:
P.O. Box 865
Cookeville, Tennessee 38501
615/526-9761

P.O. Box 38
1648 Thomas Street
Memphis, Tennessee 38101
901/525-4391

P.O. Box 2459
White City, Oregon 97501
503/826-2756

SECCA (Parent Company - COFIEC)
Guayaquil, Ecuador
Ing. Fernando Gonzalez,
Acting General Manager

Production Plant:
Guayaquil, Ecuador
(operated by T. S. Ragsdale)

STANDARD MILLING COMPANY
1009 Central Street
Kansas City, Missouri 64105
816/BA1-8200
Mr. Paul German

Production Plant:
Meta, Missouri
314/229-4210

TIMBERLAND PRODUCTS CO., INC.
4124 Boulevard Center Drive
Jacksonville, Florida 32207
904/398-1126

TWIN LAKES CHARCOAL
Cotter, Arkansas 72626
501/435-6784
Dr. M. O. Raine
Mr. Tom Stiles
Mr. Charlie Welsh

WESTERN BARBECUE SUPPLY COMPANY
Sallisaw, Oklahoma
918/SP5-4410
Paul Mothershed, President

WEYERHAEUSER COMPANY
Dierks Division
P.O. Box 1060
Hot Springs, Arkansas 71901
501/623-7762
Mr. Austin H. Bell,
Charcoal Sales Manager

Production Plant:
P.O. Box 38
Dierks, Arkansas 71833
501/286-2201

Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 44-46.

The majority are of a very small size, still using old methods of production. However as indicated in Table 4, production of

Table 4

CHARCOAL BRIQUETTE PRODUCTION IN THE UNITED STATES, SELECTED YEARS (in tons)

Year	Production
1955	79,620 1/
1956	125,000 1/
1961	235,640 2/
1963	304,500 3/
1967	335,000 4/
1968	375,000 4/
1969	415,000 4/
1970	500,000 4/
1971	550,000 5/

1/ U.S. Department of Agriculture, Forest Service, Division of Forest Economics Research, Charcoal Production in the United States, July 1957.

2/ U.S. Department of Agriculture, Forest Service, Division of Forest Economics and Marketing Research, Charcoal and Charcoal Briquette Production in the United States, 1961, February 1963.

3/ U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufactures.

4/ Figures supplied by Aeroglide Corporation, Raleigh, N.C. They represent straight-line projection of reported production by Charcoal Briquette Institute members to cover the entire industry.

5/ Estimated by Aeroglide Corporation, Raleigh, N.C.

Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 4.

charcoal briquettes in the U.S. increased from 79,620 tons in 1955 to approximately 500,000 tons in 1970, representing a compound annual growth of 13.8 percent in the last 15 years. Production estimates in the U.S. for 1971 are approximately 550,000 tons.5/

Recent charcoal production estimates for Canada are not available. Table 5 presents estimates for 1968 and 1969. The 1969 figure is lower but not significantly so.

Table 5

CANADIAN SHIPMENTS OF GOODS OF OWN MANUFACTURE 1968 AND 1969

	1968		1969	
Description	Quantity (Tons)	Value ($,000)	Quantity (Tons)	Value ($,000)
Charcoal	12,399	949	12,222	969

Source: Statistics Canada, Other Chemical Industries, Ottawa, Queen's Printer, 1970.

Foreign Trade

The pattern of exports and imports of charcoal or charcoal briquettes between Canada and the U.S. is rather difficult to decipher at the present time. There are some significant discrepancies in the available data. Table 6 gives U.S. exports and imports of charcoal briquettes by

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5/T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 3.

Table 6

UNITED STATES IMPORTS AND EXPORTS OF CHARCOAL BY COUNTRY, 1971

Exports		Imports	
Country	Quantity (Tons)	Country	Quantity (Tons)
Canada	2,000	Ecuador	12,000
Others	8,000	Mexico	5,000
		Canada	10,000

Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 5.

country, and Table 7 gives Canadian imports of charcoal by country. Since 95 percent of charcoal is briquetted we can assume the figures also represent charcoal briquettes.

Table 7

CANADIAN IMPORTS OF CHARCOAL BY COUNTRIES, 1971

Country	Quantity (Cwt)	Value ($,000)
United Kingdom	7	-
Netherlands	30	1
Japan	92	1
Ceylon	11,960	71
United States	236,554	1,303
Total	248,643	1,377

Source: Statistics Canada, Imports by Commodities, (Ottawa: Queen's Printer, 1971).

Table 7 indicates that Canada imported 12,000 tons from the U.S. in 1971, while Table 6 indicates the U.S. exported only 2,000 tons to Canada in 1971. There are no figures available for Canadian exports of charcoal. Statistics Canada includes charcoal under the heading of other wood products. This would indicate that Canadian exports of wood charcoal were not significant. However, Table 6 lists Canada as having exported 10,000 tons to the U.S. in 1971.

Table 8 lists the Canadian charcoal manufacturers.

Table 8

CANADIAN CHARCOAL MANUFACTURERS

* Atlantic Forest Products Limited, Minto, N.B. - (Briquettes)

Dufresne & Paquet & Cie Ltee., St. Raymond, P.Q.

Manitoba and Saskatchewan Coal Co., Briquetting and Char Division, Bienfait, Sask.

Muskoka Charcoal Company, Huntsville, Ontario.

Pro-Char Products Inc., La Macaza, Quebec. - (Briquettes)

*Indicates firms engaged or seriously interested in export trade.

Source: Canadian Manufacturers Association, Canadian Trade Index, Toronto: Canadian Manufacturers Association, 1971.

The small number would seem to indicate that Canada is deficient in charcoal production and therefore the Canadian data is likely more reliable than that given in the Georgia Study. The Manitoba and Saskatchewan Coal Co., burns off the tar and gases from lignite coal to produce its charcoal. Since this results in an inferior product, it is not a serious competitor to wood charcoal. Furthermore, all the char produced by this Co. is sent to North Dakota for briquetting. Atlantic Forest Products Ltd. in New Brunswick is the largest producer in Canada. Since the Canadian market is small and it is located close to the heavily populated U.S. North East, it has been exporting. The Muskoka Charcoal Co. is now out of business, its plant having burnt down in the past year.

Market Potential

It is likely that Canadian charcoal production has not increased significantly since 1969, as some companies have slowed down or shut down production and others have increased. Therefore, 12,000 tons is assumed to be Canadian production in 1971. Combined with 550,000 tons U.S. production, total North American production in 1971 was 562,000 tons.

From Tables 6 and 7, total charcoal imports from countries other than Canada or the U.S. were 18,000 tons. Exports to countries other than Canada or the U.S. were 10,000 tons. This would indicate a deficiency in production of only 8,000 tons in North America and total consumption at 570,000 tons in 1971.

Since exports and imports are not significant the

13.8 percent annual growth in production can be assumed to very closely approximate the past growth in consumption. Since purchase of charcoal briquettes represent a very minor expense in a consumers' budget, this product is likely price inelastic for price changes other than substantially large ones. With many brands on the market, making it fairly competitive, there should be no substantial price increases in the foreseeable future. Therefore, it can be assumed that over the next five years price increases will not be a factor that could contribute to a reduction of the 13.8 percent annual growth rate. With both increasing leisure time and rising standards of living, consumption should continue to increase, in the foreseeable future, at an average annual rate of approximately 13.8 percent.

Using the above given assumptions and an annual growth rate of 13.8 percent, Table 9 gives estimated charcoal requirements to meet demand over the next five years.

The figures in Table 9 indicate that production will have to approximately double within the next five years in order to meet demand. It is possible that there will be other factors involved such as those mentioned in the next paragraph, that would cause a slowing of the growth rate. But, in any case, there will be substantial increases in quantity demanded over the next five years or more.

In the last few years gas and electric grills have entered the market. The number of electric grills sold is very small and insignificant. However, it is estimated that

Table 9

ESTIMATED CHARCOAL DEMAND, 1972-1976

Year	Quantity (Tons)
1971	570,000
1972	648,660
1973	738,175
1974	840,043
1975	955,969
1976	1,089,892

one million gas grills were sold in the U.S. between 1965 and 1970.[6] According to the Georgia Study estimates, this only replaces 11,000 tons of charcoal a year or 2 percent of national consumption. Surveys indicate that they are not expected to become a serious threat to the charcoal market.[7]

Marketing

Since most of the charcoal produced today is used for residential consumption, it initially goes to briquetting plants. Therefore we are concerned with the marketing of briquettes.

The distribution of the markets roughly parallels population distribution although there are slight variations

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[6] T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 7.

[7] Ibid., p. 7.

in per capita consumption among regions. Per capita consumption in the U.S. is estimated at 5.5 pounds per year.[8] In Canada with consumption estimated at 25 tons annually and a population of 20 million, per capita consumption is only about 2.5 pounds per year. This may be a function of the seasonality and weather sensitivity of the market. A large wholesale organization in the Los Angeles area gave the following picture of the seasonal index of briquette sales.[9]

1st quarter	1.0
2nd quarter	2.3
3rd quarter	3.3
4th quarter	1.2

This pattern would progress as one continued northward with all significant sales made in the months of June, July and August. Such a market necessitates storage in the off-season.

Approximately 50 percent of total production of the United States manufacturers goes directly to the retail trade. The wholesaler and broker get about 40 percent, commercial trade 5 percent, and the industrial sector 2 percent. Wholesalers sell most of their product to retailers. Therefore eventually most of the charcoal briquettes are sold at the retail level.[10]

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[8] Ibid., p. 14.

[9] British Columbia Research Council, The Charcoal Industry, p. 5.

[10] T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 15.

Principle retail outlets for charcoal briquettes are supermarkets, accounting for about 75 percent of the retail trade. Other outlets are drug stores and convenience shops, hardware stores, and filling stations.

Prices

In a discussion of briquette prices the quality of the product must be considered. Generally speaking there are two quality categories. High quality briquettes are made using wood as a raw material. Generally this has been hardwood. Low quality briquettes use lignite, or coal coke, or boiler char, or a hardwood blend material. Low quality charcoal sells at a substantially lower price than high quality and is generally cheaper to produce.

Table 10 gives the prices of hardwood charcoal briquettes f.o.b. plant. The average is over $105 per ton. This may be an overestimate as price reductions may be given for off-season sales and carload or truckload shipments. According to the Georgia Study, industry sources estimate the range at $88 to $105 per ton and the average at $95.

Wholesale profit margins vary a lot depending on location, high-grade or low-grade briquettes, quantity purchased, time of purchase, and types of customers. The variance in profit margins could be anywhere from 7 to 30 percent of wholesale prices. Table 11 gives charcoal briquette wholesale prices for selected cities in the U.S.

The same variance on retail profit margin exists as for wholesalers and for the same reasons. Table 12 gives

Table 10

PRICES FOR CHARCOAL, HARDWOOD, RETORT, BRIQUETTES, FEBRUARY, 1971
(In Dollars Per Ton)

Size	Description	Price
5 lbs	Paper bags, Carload, Works	$ 122
10 lbs	Paper bags, Same basis	110
20 lbs	Paper bags, Carload f.o.b. Plant	108
40 lbs	Paper bags, Same basis	104

Source: Oil, Paint, and Drug Reporter, (New York: Schnell Publishing Co., February 15, 1971), p. 32.

retail briquette prices for selected cities in the U.S.

Canadian prices of charcoal briquettes are generally higher than U.S. prices. The main reason for this price differential is probably that Canada imports the majority of their briquettes from the U.S. This results in higher freight costs and also there is a 5 percent tariff on charcoal coming into Canada, while there is no tariff on charcoal going from Canada to the U.S.

The 1966 British Columbia Study on the charcoal industry states that in Vancouver the retail price of barbecue briquettes is usually in the order of $200 per ton.[11] Comparing this to Table 12, which gives the 1971 United States prices, we can see there is a substantial price differential. Quotations from a food broker in Edmonton, indicates that they

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[11] British Columbia Research Council, The Charcoal Industry, p. 8.

Table 11

CHARCOAL BRIQUETTE WHOLESALE PRICES FOR SELECTED CITIES, FEBRUARY, 1971

	5 lb.		10 lb.		20 lb.		40 lb.	
	High Quality	Low Quality	High Quality	Low Quality	High Quality	Low Quality	High Quality	Low Quality
Atlanta	$0.39	$0.38	$0.72	$0.69	$1.39	$1.29	-	-
Chicago	0.43 1/	-	0.78	0.73	1.47	1.34	$2.86	-
Houston	0.396 2/	-	0.74	-	1.42	-	2.75	-
Los Angeles	0.40 3/	0.373 4/	0.73	0.59	1.42	1.14	2.62	$2.24
San Francisco	0.40 5/	-	0.735	0.59	1.43	1.14	2.79	-
Washington, D.C.	0.42	-	0.76	-	1.46	-	-	-

1/ 5 5-lb. bags - $2.15

2/ 6 5-lb. bags - $2.38

3/ 6 5-lb. bags - $2.40

4/ 6 5-lb. bags - $2.24

5/ 6 5-lb. bags - $2.40

Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 17.

Table 12

SUPERMARKET CHAIN STORE CHARCOAL BRIQUETTE PRICES
FOR SELECTED CITIES, FEBRUARY, 1971

	5 lb.		10 lb.		20 lb.	
	High Quality	Low Quality	High Quality	Low Quality	High Quality	Low Quality
Atlanta	-	-	-	$.65	-	$.99
Chicago	-	-	$.79	-	$1.39 1/	-
					1.59	
Houston	$.43	-	.79 1/	-	1.29 1/	-
			.99		1.79	
Los Angeles	.59	-	.79-.89 2/	-	1.59-1.69 2/	-
Washington, D.C.	.39	-	.69	-	1.35	-

1/ Private label.

2/ Price range is for stores located in northern California, and the variance in price can be attributed to difference in transportation costs.

Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 18.

buy, for wholesalers, from the manufacturer out of Dickinson, N.D. at $.72 per 10 lb. bag for low grade, and $.85 for high grade. These prices include freight costs to Edmonton.

Transportation Costs

Due to the geographical distribution of producers, transportation costs play an important role in the pricing of briquettes. The industry relies primarily on rail and truck transportation. Approximately half the production goes by rail, the remainder by truck.[12]

Figures 5 and 6 present railroad, and truck freight rates respectively, for briquettes shipped out of Rome, Georgia. Comparisons indicate that railroad rates are cheaper over all distances.[13] Over shorter distances the rates are slightly competitive, while over long distances truck transportation becomes completely unfeasible.

Table 13 gives 1966 freight rates to western markets, and Table 14 gives Canadian CNR freight rates from selected centres. Those given in Table 14 are general rates as there are no classified rates for charcoal briquette shipments. These then are maximum rates, as it was indicated by CNR officials that negotiations for classified rates would probably result in rates substantially lower than those given in Table 14.

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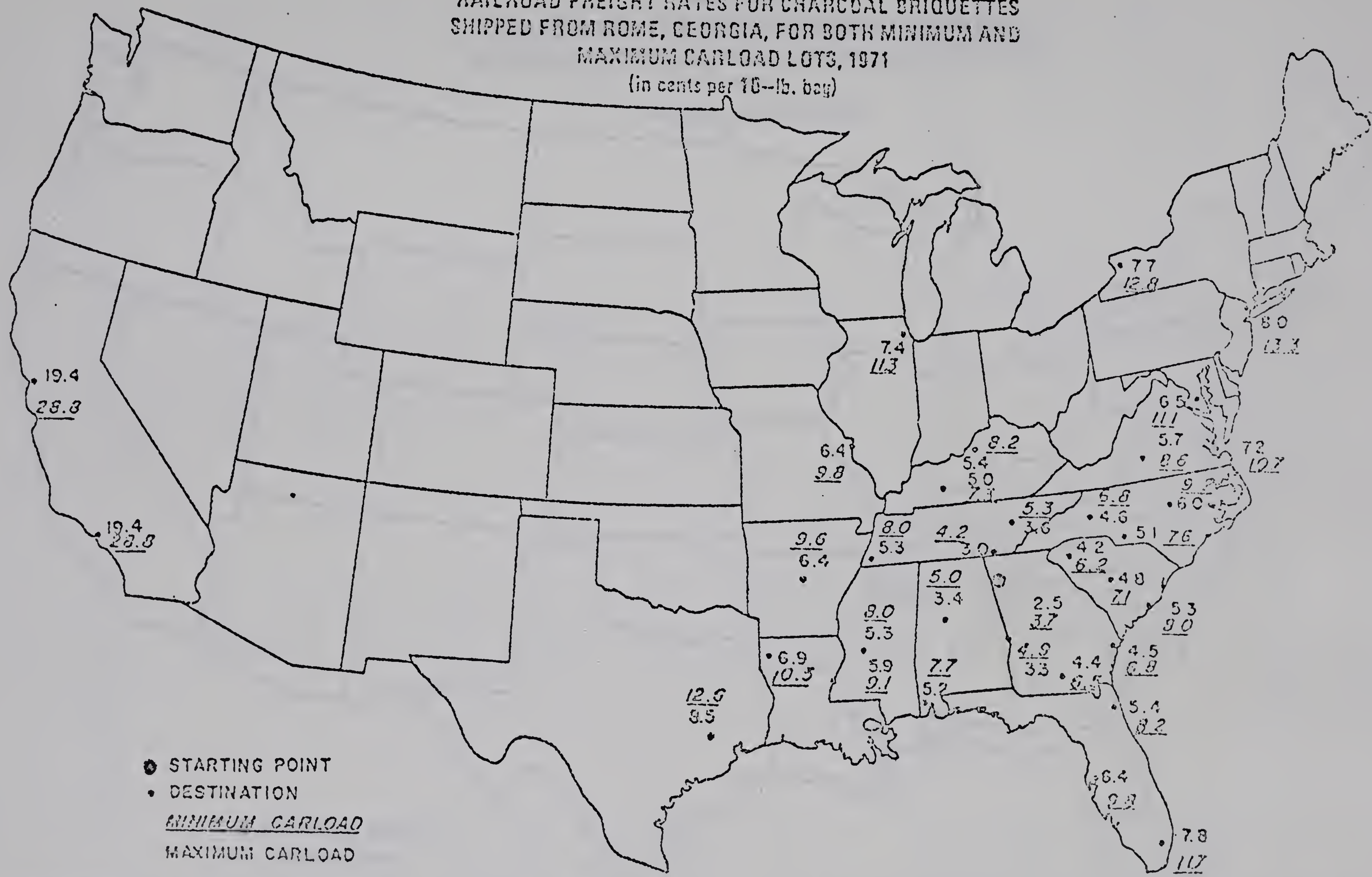
[12] T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 19.

[13] Over very short distances truck transportation would likely be the only feasible means of transportation.

Figure 5

RAILROAD FREIGHT RATES FOR CHARCOAL BRIQUETTES SHIPPED FROM ROME, GEORGIA, FOR BOTH MINIMUM AND MAXIMUM CARLOAD LOTS, 1971

(in cents per 10--lb. bag)

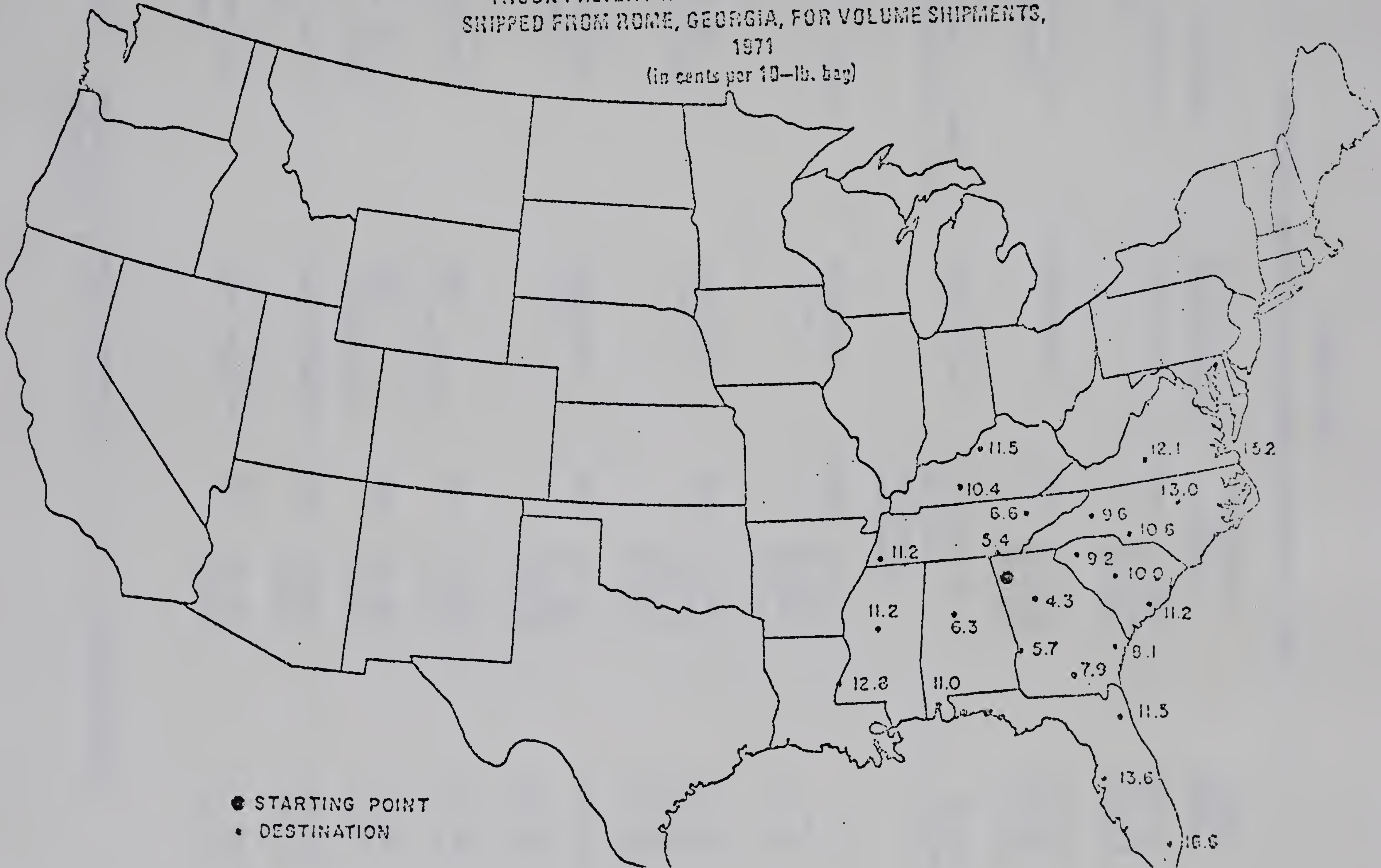


Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 28.

Figure 6

TRUCK FREIGHT RATES FOR CHARCOAL BRIQUETTES SHIPPED FROM ROME, GEORGIA, FOR VOLUME SHIPMENTS, 1971

(in cents per 10–lb. bag)



Source: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 29.

Table 13

FREIGHT RATES TO WESTERN MARKETS, 1966

Origin	Destination	Quantity (lbs)	Rate (Ton)
Iron Mountain, Mich.	Vancouver	Min. 40,000	$42.00
		60,000	27.00
		80,000	22.60
Louisville, Kentucky	Vancouver	Min. 40,000	43.80
		60,000	29.80
		80,000	26.60
Bienfait, Sask. (Dickinston, N.D.)	Vancouver	72,000 or 90,000 minimum carloads	8.29 (coal briquettes)
Pablo, Mont.	Seattle, Port.	Min. 36,000	-
		45,000	-
		58,500	11.00 (U.S.)
		80,000	-
Iron Mtn. or St. Louis	Seattle, Port.	Min. 36,000	41.00
		45,000	32.40
		58,500	28.20
		80,000	24.60
Nashville, Tenn.	Seattle, Port.	Min. 36,000	43.80
		45,000	-
		58,500	31.60
		80,000	28.50
Vancouver, B.C.	San Francisco	Min. 30,000	35.60
		60,000	21.00
Iron Mtn. or St. Louis	San Francisco	Min. 36,000	41.00
		45,000	32.40
Vancouver, B.C.	Los Angeles	Min. 30,000	44.60
		60,000	24.20
Nashville, Tenn.	Los Angeles	Min. 36,000	43.80
		58,500	31.60

Source: British Columbia Research Council, <u>The Charcoal Industry</u>, p. 7.

Table 14

CANADIAN NATIONAL RAILROAD GENERAL FREIGHT RATES, 1972

Origin	Destination	Quantity (lbs)		Rate (Cwt)
Vancouver	Edmonton	Min.	30,000	$1.56
		Excess to	60,000	.78
		Excess over	60,000	.62
Vancouver	Calgary	Min.	30,000	1.48
		Excess to	60,000	.74
		Excess over	60,000	.59
Vancouver	Regina	Min.	30,000	2.20
		Excess to	60,000	1.32
		Excess over	60,000	1.10
Vancouver	Winnipeg	Min.	30,000	2.54
		Excess to	60,000	1.78
		Excess over	60,000	1.52
Edmonton	Calgary	Min.	24,000	.68
			30,000	.58
			40,000	.51
			50,000	.42
			60,000	.37
Edmonton	Regina	Min.	24,000	1.43
Edmonton	Winnipeg	Min.	24,000	1.55
			30,000	1.40
			40,000	1.29
			50,000	1.26
			60,000	1.24
Toronto	Winnipeg	Min.	24,000	3.12

Source: Canadian National Railroad spokesman, Edmonton, 1972.

Market Structure

The market structure of this industry has elements of both oligopolistic and monopolistic competition. The following will look at charcoal manufacturing separate from briquetting. This is not totally accurate as most of the larger firms do both.

As evidenced earlier, there are a multitude of charcoal manufacturers. Most are very small, but a few are large. There is an element of monopolistic competition here in that the vast majority of these producers are too small to have any effect on the market. Charcoal before briquetting, other than for quality differences, is a standard product. However, oligopolistic competition is also a factor as some firms are very large and do affect the market. Although there is no documented evidence, indications are that some of the larger firms are price leaders.

Briquetting is an oligopolistic market situation. There are few producers and most are large enough to have an influence on the market. Briquettes are a differentiated product. Here again there are indications that some of the larger firms play the role of price leaders.

CHAPTER IV

COSTS OF PRODUCTION

This chapter will analyse the costs for existing popular methods of charcoal and charcoal briquette production. The same costs will be analyzed using the British Columbia Research Council process.

Situation A

1) Basis: two ton per hour charcoal plant, 8,000 operating hours per year (16,000 tons), existing method.
2) Capital Investment: for a two ton per hour plant it is approximately $600,000 including related machinery.[1]
3) Costs: (per ton)

Labor - 2 men/shift @ $2.75/hr. plus 22%	$ 3.36
Utilities - 500 hp-2.0¢/kwh	2.61
Maintenance - 5%/yr. on investment	1.87
Depreciation - 10 yr. straight line	3.74
Supervision	.50
Insurance and taxes - 5% on investment	1.87
Miscellaneous - contingency	2.00
Total	$15.95

[1] The figure of $600,000 and the costs are taken from: T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 32.

Situation B

1) Basis: 1, 2, and 3 ton per hour charcoal plant, 8,000 operating hours per year, British Columbia Research Council process.

	1-T.P.H.	2-T.P.H.	3-T.P.H.
2) Capital Investments:	180,000	220,000	280,000
3) Costs: (per ton)			
Labor - 2 men/shift @ \$2.75/hr. plus 22%	6.71	3.36	2.23
Utilities - 75 hp- 2.0¢/kwh	.76	.38	.25
Maintenance - fixed	.20	.20	.20
Depreciation - 10 yrs. -straight line	2.25	1.37	1.16
Insurance - 1% on investment	.23	.14	.12
Miscellaneous - contingency 5%	1.13	.69	.58
Total	11.28	6.14	4.54

Situation C

This situation was taken from unpublished estimates prepared by Aeroglide Corporation in November, 1970.

1) Basis: 2 ton per hour charcoal and briquet plant (14,400 tons per year). Wood waste raw material (multi-hearth furnace). Located at Oak Flooring Plant in Southeast.

2) Estimated Capital Required:

Furnace and related machinery	$ 350,000
Charcoal storage, building or bolted tanks	55,000
Briquet manufacturing building, 60" x 120" @ $2.50/ft.	18,000
Briquet storage building, 100' x 420' @ $2.50/ft.	105,000
Electrical wiring, lights and plumbing	12,500
Office, baths, and showers	10,500
Total - Furance and buildings	551,000
Plus 5% ($27,550) contingencies	578,550
Aeroglide Charcoal Briquet Machinery	156,000
Aeroglide Dust Control and Fines Recovery	25,000
Freight-factory to job site	3,500
Installation labor @ $5.00/hr.	12,500
Small crane service @ $10.00/hr.	600
Large crane service @ $35.00/hr.	2,100
Installation tools (for shop use later)	1,500
Aeroglide Installation Technician	6,600
Aeroglide Start-Up Technician	4,800
Total - Briquet Machinery	212,600
Plus 5% ($10,630) contingencies	223,230
Tractor with front end loader	5,500
Industrial fork lifts (2 required)	13,000
Air compressor	900
Moisture meter	500
Check-weighing scales	1,500
Spare parts inventory	5,000
Total - Equipment	26,400
Plus 5% ($1,320) contingencies	27,720
Total Initial Capital Required	829,500
Total Operating Capital Required	200,000
GRAND TOTAL	$1,029,500

3) Estimated Profit Potential:

General Manager	$ 12,000
Sales Manager	10,000
Plant Manager	7,800
Plant Engineer (Maintenance)	6,000
Secretary	4,420
Furnace Depreciation (10 yrs.)	35,000
Building Depreciation (40 yrs.)	5,276
Machinery Depreciation (10 yrs.)	22,323
Equipment Depreciation (10 yrs.)	2,772
Insurance and taxes (1% of investment)	8,295
Interest, long term capital (8.0%)	66,360
Interest, operating capital (10%, 6 mos.)	10,000
Maintenance, supplies and miscellaneous)	19,754
ANNUAL FIXED COSTS	$210,000

	HOURS/YEAR OPERATION	
	6,000	7,200
Outside Wood Costs	$ 10,000	$ 10,000
Lignite or other additives @ $32/ton	64,000	140,800
Corn Starch @ $5.85/cwt (10% mix)	140,400	168,480
Consumer Bags and Master Containers	84,000	100,800
Trucking Costs (2 trucks, 6 vans)	25,000	25,000
Utilities - Charcoal Production	12,010	12,010
Briquet Production	24,000	28,800
Labor - Charcoal Production	41,911	41,911
Briquet Production	81,000	97,200
Brokerage @ 5% of $90.00/ton	54,000	64,800
Travel and Promotion @ $0.50/ton	6,000	7,200
Association Fees @ $0.15/ton	1,800	2,160
Management Team Incentive @ $1.00/ton	12,000	14,400
Miscellaneous @ $0.50/ton	6,000	7,200
ANNUAL VARIABLE COSTS	$562,121	$720,761

4) Cost and Profit Summary:

Total Annual Briquet Production, Tons	12,000	14,400
Fixed Cost Per Ton	$ 17.50	$ 14.58
Variable Cost Per Ton	46.84	50.05
TOTAL COST PER TON	$ 64.34	$ 64.63
Profit before Taxes		
@ $64/ton Break Even	---	---
@ $85/ton Price	$247,920	$293,328
@ $95/ton Expected Price	$367,920	$437,328

Situation D

1) Basis: Briquetting plant operating own British Columbia Research Council charcoal reactor. 8,000 hours/yr.

2) Estimated Capital Required:

	1-T.P.H.	2-T.P.H.	3-T.P.H.
Land (by owner)	-	-	-
Black top, etc.	10,000	15,000	20,000
Engineering Plans	6,000	10,000	18,000
Charcoal Storage or Tanks @ $2.50/ft.	7,200	12,000	16,000
Briquette Manufacturing Building @ $3.50/ft.	21,000	30,240	40,000
Briquette Storage @ $2.75/ft.	99,000	198,000	300,000
Electric Wiring	8,550	13,900	20,000
Air, Water, Fuel, Plumbing	2,300	3,200	4,000
Office, Bathroom, Showers	2,000	2,500	3,000
Total	140,050	259,840	383,000
Contingencies 5%	7,003	12,992	19,150
	147,053	272,832	402,150
B.C.R.C. Charcoal Reactor Installed	180,000	220,000	280,000
Charcoal Handling Bins	20,000	40,000	60,000
Standard Briquette Plant	145,000	180,000	250,000
Freight Average	2,000	3,000	4,000
Installation Labor and Tools	13,500	18,500	25,000
Accessory Equipment	19,250	27,900	40,000
Spare Parts Inventory	2,500	3,500	4,500
Shop Equipment	2,500	3,000	3,500
Installation Technician	4,500	6,750	8,500
Start Up Technician	4,500	4,500	4,500
Miscellaneous Equipment and Services	10,000	12,000	14,000
Total	403,750	519,150	694,000
Contingencies 5%	20,186	25,958	34,700
	423,936	545,108	728,700
Total Initial Capital	586,989	842,940	1,168,850
Total Operating Capital 40% Production (based on $50.00 per ton)	160,000	320,000	480,000
Total Capital Required	746,989	1,162,940	1,648,850

	1-T.P.H.	2-T.P.H.	3-T.P.H.
3) Costs of Production:			
A) Fixed Costs (annual)			
Plant Manager	10,000	12,000	14,000
Office Personnel	7,000	9,000	12,000
Maintenance Engineer	7,000	7,000	9,000
Building Depreciation (40 yrs)	3,676	6,821	10,054
Machinery Depreciation (10 ")	42,394	54,511	72,870
Insurance	5,870	8,429	11,689
Interest Initial Capital 8%	46,959	67,435	93,508
Interest on Operating Capital 7% - 6 mos.	5,600	11,200	16,800
Maintenance and Miscellaneous	6,000	9,000	12,000
Total Fixed Cost	134,499	185,396	251,921
Fixed Cost Per Ton	16.81	11.58	10.49
B) Variable Costs (annual)			
Grain Starch 10% ($5.85/cwt)	93,600	187,200	280,800
Bags and Master Containers	28,000	48,000	66,000
Labor - Charcoal $2.75/hr.	53,760	53,760	53,760
Briquetting $2.75/hr.	110,000	147,520	204,640
Utilities - Charcoal $2.75/hr.	6,080	6,080	6,080
Briquetting $2.75/hr.	16,000	32,000	48,000
Association Fees @ $0.15/ton	1,200	2,400	3,600
Production Incentives @ $0.25/ton	2,200	4,400	6,600
Miscellaneous @ $0.50/ton	4,000	8,000	12,000
Total Variable Cost	312,840	489,360	681,480
Variable Cost Per Ton	39.10	30.52	28.38
Total Cost Per Ton	55.91	42.16	39.87
4) Estimated Profit Potential:			
Total Cost Per Ton	55.91	42.16	39.87
Royalty Cost Per Ton	3.00	3.00	3.00
TOTAL	58.91	45.16	42.87
Profit Per Ton @ $0.80/ton	22.09	35.84	38.13
Total Profit Before Taxes	176,720	573,440	915,120
Depreciation, 10 years	46,070	61,332	82,924
Cash Flow	134,430	348,052	540,484
Payout Period	4½ years	2½ years	2 years

Summary

From the above cost breakdown two significant things become apparent:

1. The B.C.R.C. process can produce and briquette charcoal at a substantially lower rate than other popular processes.
2. There are large economies of scale to be had by building a two ton per hour rather than a one ton per hour plant. Any economies of scale drop off drastically when going from a two to three ton per hour plant.

CHAPTER V

LOCATION THEORY

Introduction

> "The locational problem as it faces the individual firm in an industry is much less complex than general location theory which is concerned with all economic activities in space and needs to explain production locations and inter-regional flows of inputs and commodities simultaneously. As yet no fully satisfactory general theory of location has been developed."[1/]

The theories of location shall not be treated in their entirety in this chapter. Rather the portions relevant to the charcoal industry will be isolated and discussed in the context of locating charcoal manufacturing plants. The last chapter examines plant location in terms of source of raw materials and proximity to market. This chapter will try to focus on the theoretical framework that fits this.

Alfred Weber

Alfred Weber, a German economist, who in 1909 published a treatise on the location of industry, had great influence on the development of location theory. In his theory, transportation costs play the deciding role in making the decision of where to locate. His transportation costs were a function of

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[1/] H. W. Richardson, Regional Economics, England: Weidenfeld and Nicolson, 1969, p. 101.

weight and distance. All other factors affecting transportation cost were allowed for by appropriate additions to weight and distance.[2]

Weber classified materials into two main categories:[3]

1) Ubiquities: These are materials that are available everywhere and presumably at the same price.

2) Localized materials: These are obtainable only in geographically well defined areas. These can be further termed as pure materials, which enter the extent of their full weight into the finished product, or gross materials, which impart only a portion or none of their weight to the finished product.

Other important assumptions he makes are that he is dealing with a single product, or at least only considers a single product at a time. Goods of different quality, though similar, are treated as different products. In this manner he assumes away competition.[4] He also assumes that demand for the product of a firm is formed at a point and that it is independent of the sellers' location.[5]

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[2] S. Daggett, Principles of Inland Transportation, (U.S.: Harper and Brothers, 1955), p. 58.

[3] Ibid., pp. 58-59.

[4] Ibid., p. 58.

[5] M. Greenhut, "Integrating the Leading Theories of Plant Location", Southern Economic Journal, 18, July 1951-April 1952, p. 219.

Weber then introduced the concept of the material index. This indicates the proportion which the weight of localized materials bears to the weight of the finished product.[6]

$$\text{Material Index} = \frac{\text{Weight of Localized Material}}{\text{Weight of Product}}$$

For example, a productive process which uses pure materials has a material index of 1. Industries with a high material index in their production process are attracted toward the raw material source. Industries with a low index are attracted to the market.

<u>August Lösch</u>

Lösch assumes a vast plain with an equal distribution of raw materials, ubiquitous transportation possibilities, an even distribution of population, identical consumer tastes and preferences, and production opportunities open to all.[7]

Using these assumptions, he developed the idea of a price funnel and a demand cone.[8]

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[6] S. Daggett, <u>Principles of Inland Transportation</u>, p. 59.

[7] H. W. Richardson, <u>Regional Economics</u>, p. 105.

[8] A. Lösch, "The Nature of Economic Regions", <u>Southern Economic Journal</u>, 5, (1938-1939), p. 73.

Figure 7

LÖSCH'S PRICE FUNNEL AND DEMAND CONE

FIGURE 7 - I

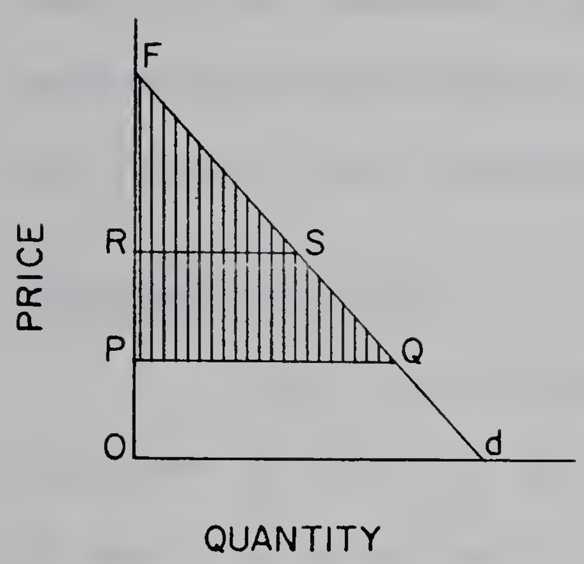
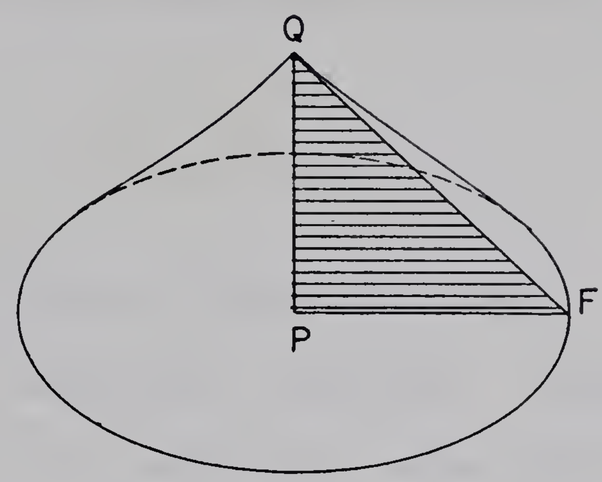


FIGURE 7 - II



Assume the demand curve in Figure 7-I to be an individual demand curve. If OP is the demand at the centre of production then people living there will demand PQ. Letting PR be the transportation cost from P to R, then people living there will demand RS. The farther you go out, with transportation costs increasing, the less you sell, until you reach F at which point none is sold. Therefore PF is the maximum shipping radius for the product. Figure 7-II illustrates that total demand within that radius is what you get by rotating triangle PQF in Figure 7-I around PQ.

According to Lösch, the trading area will not remain a circle. New competitors are going to enter in the empty spaces created by three adjacent circles and the result will

be a series of hexagon shaped trading areas.[9]

Lösch, as opposed to Weber, realized the importance of contact with the market. He also did not assume away the existence of competitors, but included them to the extent that competition squeezed together the round sales areas into regular hexagons until both profits and areas not served by the product had disappeared.[10]

Charcoal Industry

The locational characteristics of the charcoal industry do not fit any one of the described theories. Rather it has characteristics of them both; in addition, some theories put forth by other economists fit certain aspects of this industry.

According to Weber, transportation costs play the deciding role in making the decision as to where to locate. This is certainly the case with the charcoal industry. Differences in production costs alone cannot overcome transportation costs over large distances. If a new producer hopes to be able to break into the market, he has to be able to produce at a low enough cost (C.I.F.) such that he will be able to sell at a lower price than his competitors to brokers and wholesalers.

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[9] For a more complete discussion, see; A. Lösch, Southern Economic Journal, 5, p. 73.

[10] S. Valavanis, "Lösch on Location", American Economic Review, 45, 1955, p. 638.

In the following analysis, it will be assumed that all factors of production other than wood wastes are ubiquitous. With the exception of labour and capital equipment, the other inputs in charcoal production represent only a very small percentage of costs. These are available almost anywhere and at very little difference in cost; therefore, they have no significant influence on the location site. The required capital equipment represents a large proportion of costs; however, it can be transported anywhere at no significant difference in total cost. Since labour costs represent a fairly large proportion of total cost of production, regional wage rate differentials could possibly have some effect on costs of production. However, these differences would have to be quite large. It is beyond the scope of this study to examine wage rate differentials; therefore, labour costs will be assumed to be the same everywhere.

Charcoal yield to dry wood weight is generally 20-25 percent. Assuming a yield of 25 percent gives a material index of 4. According to Weber, this would indicate that location should be near the source of raw material. The large weight loss combined with the large weight per operative suggests a strong locational tie to the source of raw material. Loss of weight may have significant locational effects only when it is combined with large weight per operative, for variations in transportation cost are substantial enough to affect locational weight only if weights handled are large.[11/]

[11/] W. Smith, "The Location of Industry", I.B.G. Transactions, 21, (England: Institute of British Geographers, 1955), p. 10.

Weber implicitly assumes that the demand for the product of a firm is formed at a point and that it is independent of the seller's location.[12] This assumption does not fit the charcoal industry. Demand is not formed at a point but rather throughout a market area. Weber assumes away the existence of competitors. However, their very existence means that demand for the product of a particular firm is not independent of the seller's location. The producer will find a demand for his product in an area only if his selling price (C.I.F.) is such that it is not significantly higher and preferably lower than that of his competitors.

Lösch, on the other hand, realized the importance of contact with the market and noted that, competition played an important role in the location of industry. His description of price funnels and demand cones is realistic to the charcoal industry in that a producer cannot easily serve a market area that is situated far from his plant. One minor criticism one can make of this part of Lösch's model is that he neglected cross elasticities in assuming demand for a good as a function of only its own price. Certainly relative price changes of goods complementary to and substitutes for charcoal may have an effect on its demand.

The most unrealistic assumption Lösch makes is that of a vast plain with an equal distribution of raw materials.

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[12] M. Greenhut, Southern Economic Journal, 18, p. 225.

This assumption would mean that the only locational consideration is the market. With the charcoal industry this is definitely impossible since that would mean more than doubling the transportation costs.

The rapid technological change has not had a significant effect on the economics of location. The older processes had more weight loss in production than the newer ones; however, the changes in weight loss have not been significant enough to pull plant locations away from the source of raw materials.

It is probable that labour was a stronger consideration with the older processes. The newer processes are K-intensive. Therefore, labour is not an important factor. However, it was probably not nearly as strong a locational consideration as the source of raw material and the market.

Transportation costs and proximity to the market was an important consideration in the past, due to limited modes of transportation and significant costs. Due to cost considerations it is still a very important factor today.

Summary

The locational characteristics of the charcoal industry are such that they do not precisely fit either of the two leading theories. Weber's role of transportation costs as regards a weight losing industry are an important consideration for the charcoal industry, and so is Lösch's emphasis on contact with the market.

The situation is such that a charcoal manufacturer has to locate in a market area, where there is also a source

of raw material. This is perhaps best summed up by Greenhut's maximum-profit location.[13] "By definition the maximum profit location (real least-cost location) is that site from which a given number of buyers can be served at the lowest total cost."

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[13] M. Greenhut, Southern Economic Journal, 18, pp. 225-226.

CHAPTER VI

PLANT LOCATIONS

Introduction

The procedure followed in this section will be to first determine the areas in North America, that are deficient in charcoal briquette production. The wood wastes, generated in these same areas, will then be estimated to determine whether or not they are adequate enough to feed a charcoal reactor. If an adequate source of raw material is found in these areas, that are not self-sufficient in charcoal briquette production, they will be deemed to be potentially favourable areas for location of charcoal reactors and briquetting plants. At these locations, producers would enjoy a freight advantage over imported competing brands. This would enable them to easily obtain a substantial share of the market.

Location of Plants by Market Areas

A. South Atlantic: Figure 4, which lists the geographical distribution of charcoal briquetting plants in the United States, shows there is little briquette production in the South Atlantic area. In this area, numbered 1 to 6 in Figure 8, there are only 3 small (1-3 ton per hour) briquetting plants, with the exception of the large one at the very South Eastern tip of Tennessee.

Since exact plant capacity is not given in Figure 4, an assumption about total output in the area has to be made. Assuming an average output of 2 tons per hour for each of the

Figure 8

CANADA AND THE UNITED STATES

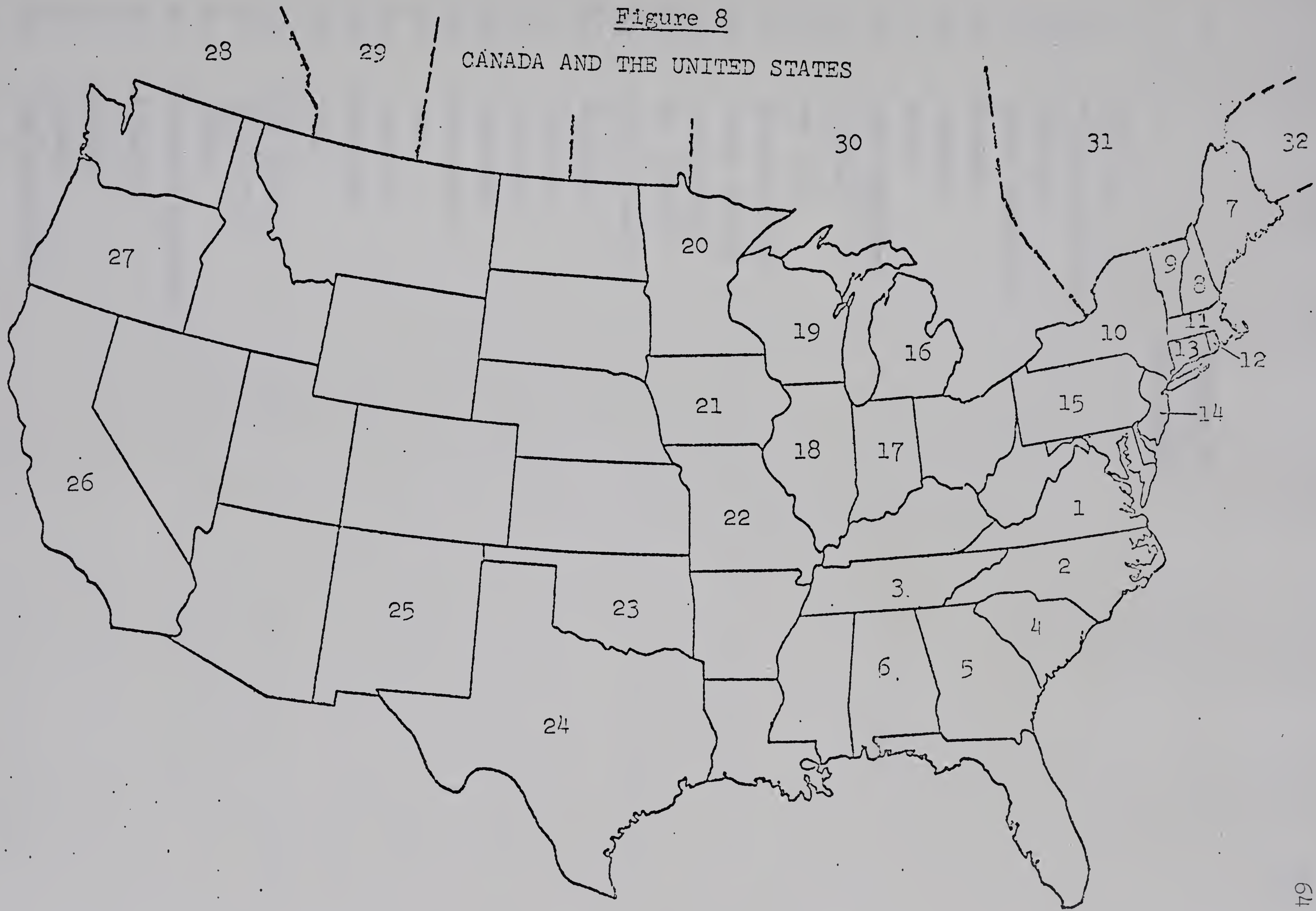

Figure 9

MAP INDEX

1. Virginia
2. North Carolina
3. Tennessee
4. South Carolina
5. Georgia
6. Alabama
7. Maine
8. New Hampshire
9. Vermount
10. New York
11. Massachusetts
12. Rhode Island
13. Connecticut
14. New Jersey
15. Pennsylvania
16. Michigan
17. Indiana
18. Illinois
19. Wisconsin
20. Minnesota
21. Iowa
22. Missouri
23. Oklahoma
24. Texas
25. New Mexico
26. California
27. Oregon
28. British Columbia
29. Alberta
30. Ontario
31. Quebec
32. New Brunswick

three plants, and operated approximately 7,000 hours a year each, gives a total yearly output of 45,000 tons.

The population for the states in this area is given below:

1.	4,648,000
2.	5,082,000
3.	3,924,000
4.	2,591,000
5.	4,590,000
6.	3,444,000
Total	24,279,000

With per capita consumption at 5.5 lbs. per year, as given in the Georgia Study, total yearly consumption in these six states is 133,534,500 lbs., or 66,768 tons. This represents a production shortage of 21,000 tons per year.

A large plant could locate in the general area of where the states of North and South Carolina, and Georgia meet, and obtain a freight advantage over a large part of this area.

Several small plants, located in key positions, could also obtain substantial freight advantages and easily break into the market. Such locations could be:

1) North East Virginia; besides serving a large part of Virginia, a plant located here could export, having a large freight advantage, to the neighbouring states north of Virginia
2) Central North Carolina
3) Northern Georgia
4) Central Alabama

More detailed studies of the particular areas would have to be

made, to best determine the exact locations and sizes of these charcoal plants.

B. North Eastern States: There is virtually no briquette production in the North Eastern States. The closest is a small plant in Pennsylvania and one in New Brunswick, Canada. The plant in Canada is just establishing itself, and the one in Pennsylvania produces approximately 15,000 tons per year.

The population for the states in this market area is given below.

7.	994,000
8.	738,000
9.	445,000
10.	18,191,000
11.	5,689,000
12.	950,000
13.	3,032,000
14.	7,168,000
15.	11,794,000
Total	49,001,000

Since this area is in the North, per capita consumption of charcoal briquettes is likely less than the National average of 5.5 lbs. per year. Assuming it is 5.0 lbs. per year, then total consumption is 245,005,000 lbs. of charcoal briquettes per year, or 122,503 tons.

Such a tremendous production shortage in the area indicates that, plants of a variety of sizes could locate at many different places, given an adequate supply of raw material.

C. North Central States: In this area there are three small plants; two in Wisconsin and one in Minnesota. Their total combined yearly capacity is approximately 45,000 tons. Most of the product sold in this area would now come from the state of Missouri, which has three large, and two small plants.

The population for this area is:

16.	8,875,000
17.	5,194,000
18.	11,114,000
19.	4,418,000
20.	3,805,000
21.	2,825,000
Total	36,231,000

Per capita consumption is probably also less in this area. At 5.0 lbs. per year per person, total consumption is 181,155,000 lbs., or 90,578 tons. This represents a production shortage of approximately 35,000 tons a year.

There are several possible locations in this area. Michigan, Indiana, South Western Illinois, Northern Minnesota, and Iowa. Since there are no duties on charcoal going from Canada to the United States, plants located in Southern Ontario or Southern Quebec could also serve part of this market area.

D. South Central: In this area there are only two small plants; one in Eastern Texas, and one in Eastern Oklahoma. Their combined output is approximately 30,000 tons per year.

Population in each of these three states is:

23.	2,559,000
24.	11,197,000
25.	1,016,000
Total	14,772,000

Since this area is in the South, per capita consumption can be assumed to be above the National average at 6.0 lbs. per year. This gives total consumption of 88,632,000 lbs., or 44,326 tons per year.

Even though the production shortage is not large, a freight cost advantage can be obtained by setting up plants just west of the ones in Texas and Oklahoma, and one in New Mexico.

E. California: There are two plants in California. Their total combined capacity is approximately 49,000 tons per year.

The population of California is 20,000,000. Located on the south west coast, per capita consumption would be higher than the National average. At 6.0 lbs. per year, total consumption is 120,000,000 lbs., or 60,000 tons.

The production shortage indicates that a small plant could be set up in California.

F. West Central States: None of these states have any charcoal briquetting plants. Though population in this area is low, relative to the rest of the United States, in any one state it is large enough to consume the output of at least one small reactor. However, because of the limited forest activity, it would be difficult to find a sufficient concentration of wood residues. Plants, located in states neighbouring

this area, could be made larger, and export to the parts of this area in which they have a freight advantage.

G. Western Canada: There are no plants in Western Canada. Table 2 gives the population of British Columbia and Alberta as being 2,184,621 and 1,627,874 respectively. With per capita consumption 2.5 lbs. per year, total consumption is 9,581,238 lbs., or 4,796 tons. A small plant, located in Southern British Columbia, could hope to capture a large part of this market and also export to the North Western states.

H. Ontario and Quebec: There are no plants in either of these provinces. Their combined population is 13,730,870. With a per capita consumption of 2.5 lbs. per year, total consumption is 34,327,175 lbs., or 17,163 tons per year.

Two small plants, one in each of Ontario and Quebec, could serve the extent of these provinces. If the plants could be located in the south of the provinces, given adequate wood residues, then they could be larger and serve part of the neighbouring United States markets.

Effects of Increasing Demand

Consumption of charcoal briquettes in North America, based on past trends, will likely double within the next five years. This will naturally cause some changes in the pattern of production and consumption as given above. Some areas, that are not at present deficient in production, may become so if there are no changes in output capacity. Also areas, in which there is at present a production shortage, will find this shortage increasing.

The producer, when determining the centre of location and size of plant, should carefully assess the present and future situation. It would be more profitable for the producer to build a large plant and operate it at less than full capacity for a few years, than to build a small plant and find in a few years that he could be selling more than he is able to produce. Also, an area that may not, at present, appear to be able to support the output of a plant operated at full capacity, may be able to do so in a short period of time.

Wood Waste Requirements

An important aspect of plant location is being able to locate in a place with continuously available, adequate source of wood residues. Charcoal yield, to dry wood weight, is generally 20-25 percent. Assuming a 20 percent yield, then for the smallest carbonizer of 1 ton per hour output, 60 tons per day of waste material, measured on a dry basis, is required. Since wood waste is not dry, green weight requirements are higher. With an average moisture content of 40 percent, 100 tons per day green weight of waste material is required. Operated 50 weeks a year, yearly requirements are 35,000 tons.

The size of the plants, and the number of plants, will vary according to the market potential of the area of location. Therefore, precise raw material requirements will have to be determined for each plant individually.

Disposition of wood waste by mills is quite a problem. Some of it is used by pulp mills as a fuel, and as a source of raw material for their product. However, many mills are now

finding it more economical to use gas, instead of wood waste, as a fuel. The remainder of the waste is disposed of by burning in a T.P. type burner. This involves a capital cost of approximately $40,000 for a large burner. Added to that there are maintenance and labour costs, which are not very high, as the burner is self-fed by a conveyor. Air pollution may also be a problem associated with burning the waste. The addition of a recycle unit for pollution control would cost about $25,000. The following article gives an idea of the scope of the problem.[1/]

SOLVING SAWDUST PROBLEM

> For a century sawdust piles have stood like ignominious mountains defying the American wood cutters' ingenuity. Charitably, they were considered a necessary evil of doing sawmilling.
>
> Yard crews worked around these great globs of waste, while mill-owners tried to ignore them. When something occupies 10 to 20 percent of the available space for doing business, represents a worthless equivalent to one-quarter of the lumber produced, and grows larger every day, it's difficult to ignore it.
>
> There seems to be no single answer to the residue problems generated by a sawmill, short of paralyzing capital expenditures. Simple economics demand answers be found, if for no other reason than to meet the standards of our environmental protection agencies.
>
> Some Illinois mills have moved a limited quantity of sawdust into commercial livestock channels. This outlet has been at best an "on

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[1/] The Southern Lumberman, (Nashville, Tennessee: May 15, 1972), p. 22.

again-off again" operation. Recognition of sawdust as a superior bedding material by the livestock industry has been slow. Those using it are sold, others need to be introduced to its fine qualities. A good product, readily available, at a reasonable price has the "sweet smell of success" about it. That's sawdust! But, it may need some merchandising.

Several mills have begun doing just that. Home-made hoppers have been built. The dust is draglined or blown into the hoppers. (A word of caution - an agitation system will help dislodge packed dust.) With a hopper, trucks can be quickly loaded. The need for a scoop is eliminated. With such quick easy loading facilities a farmer returning empty from the grain elevator is much more likely to stop by and pick up a load of sawdust.

There is no single or easy answer to the sawdust problem. This may be a source of relief and possibly profit. Why not give it a try?

Naturally the wood residues in any one state or province are not concentrated in one area, since it is a product of many different plants. However, if lumber activity is intensive enough in any one state, then a central location could easily be found where there is an abundant source of raw material. Finding such a central location would probably not be necessary, unless the decision was to set up one large charcoal reactor. There are mills, in any area supporting a fair amount of lumbering, that generate at least enough waste to feed a small charcoal reactor. Some mills could easily supply a large reactor.

The wood residue is not all in fine particles, such as sawdust. Much of it is in the form of bark. Larger pieces, such as bark, may not be used whole in fluid-bed reactors. However, if a hogger is put adjacent to the reactor and the

bark fed to it, it will then emerge in desirable sized pieces.

Estimating Wood Residues

In determining location, by the availability of wood wastes, the concern will not be in pinpointing a very specific location in a state or province. The amount of wood residues produced in the particular state or province, will be estimated, and if found abundant enough, will be deemed a suitable location. More precise information on lumber activities, in any one state or province, would be necessary to pinpoint exact locations. In some cases, speculation on desirability of location within a boundary, may be possible.

The method of approximating wood wastes will be rather crude, but should yield reasonable approximations. The Georgia Study reports, that the total volume of barks produced in the state of Georgia exceeds two million tons a year, while the non-bark residues exceed 3.6 million tons a year. About 70 percent of the barks generated in Georgia come from pulp and paper related mills, and about 80 percent of the non-bark residues are generated by sawmills.[2/] Table 15 shows that the state of Georgia produced 1,090 million board feet of lumber in 1970. Assuming that the quantity of waste generated is a function of board feet of lumber produced, then it takes approximately 100 million board feet of lumber to produce half a million tons of wood waste. It is probable that in

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[2/] T. Chiang and D. Clifton, The Feasibility of Manufacturing Charcoal and Charcoal Briquettes by Converting Barks in Georgia, p. 20.

any province or state, producing over one and a half million tons of wood waste a year, there would be at least one concentration of waste, or one mill alone generating enough waste to feed a charcoal reactor.

Availability of Wood Waste by Location

Table 15, using numbers corresponding to Figure 8, will estimate, from Tables 18 and 19 the amount of wood wastes generated by state or province. The "yes" in the column labelled, "Potential Centres of Production", means there is likely enough waste in these areas to sustain production.

Table 15

WOOD WASTE ESTIMATES

Location	Board Feet of Production (Millions)	Estimated Wastes (Millions of Tons)	Potential Centres of Production
1	1,077	5.5	Yes
2	1,171	6	Yes
3	547	2.5	Yes
4	715	3.5	Yes
5	1,090	5.5	Yes
6	1,291	6.5	Yes
7	333	1.5	Yes
8	144	.5	No
9	No listing[1]		-
10	276	1.3	-
11	93	.5	No
12	No listing		-
13	27	.3	No
14	29	.3	No

[1] This may be an indication that production is very limited.

Location	Board Feet of Production (Millions)	Estimated Wastes (Millions of Tons)	Potential Centres of Production
15	525	2.5	Yes
16	407	2	
17	171	.8	No
18	144	.7	No
20	Summation listing[2]		No
21	"		No
22	"		No
23	176	.8	No
24	894	4.5	Yes
25	302	1.5	Yes
26	5,093	25	Yes
28	22,681	113	Yes
29	1,749	8.5	Yes
30	7,460	37	Yes
31	12,721	63	Yes

[2] Numbers 20, 21, 22 are not listed individually in Table 3. They are listed in a total figure given as West North Central Division. With 611 as total production, it is likely that there is not an adequate concentration of wood waste.

Table 16

UNITED STATES POPULATION BY STATE, 1970
(in thousands)

State	1970 Population
UNITED STATES	203,185
New England	11,847
Maine	994
New Hampshire	738
Vermount	445
Massachusetts	5,689
Rhode Island	950
Connecticut	3,032
Middle Atlantic	37,153
New York	18,191
New Jersey	7,168
Pennsylvania	11,794
East North Central	40,253
Ohio	10,652
Indiana	5,194
Illinois	11,114
Michigan	8,875
Wisconsin	4,418
West North Central	16,324
Minnesota	3,805
Iowa	2,825
Missouri	4,677
North Dakota	618
South Dakota	666
Nebraska	1,484
Kansas	2,249
South Atlantic	30,671
Delaware	548
Maryland	3,922
D.C.	757
Virginia	4,648
West Virginia	1,744
North Carolina	5,082
South Carolina	2,591
Georgia	4,590
Florida	6,789

Table 16 (continued)

East South Central	12,805
Kentucky	3,219
Tennessee	3,924
Alabama	3,444
Mississippi	2,217
West South Central	19,322
Arkansas	1,923
Louisiana	3,643
Oklahoma	2,559
Texas	11,197
Mountain	8,284
Montana	694
Idaho	713
Wyoming	332
Colorado	2,207
New Mexico	1,016
Arizona	1,772
Utah	1,059
Nevada	489
Pacific	26,526
Washington	3,409
Oregon	2,091
California	19,953
Alaska	302
Hawaii	770

Source: U.S., Department of Commerce, Bureau of the Census, Current Population Reports, Series P-25, Number 459, (Washington: U.S. Government Printing Office, 1970).

Table 17

CANADIAN POPULATION BY PROVINCE, 1971

Province	Total
CANADA	21,568,311
Newfoundland Terre-Neuve	522,104
Prince Edward Island Ile-du-Prince-Edouard	111,641
Nova Scotia Nouvelle-Ecosse	788,960
New Brunswick Nouveau-Brunswick	634,557
Quebec	6,027,764
Ontario	7,703,106
Manitoba	988,247
Saskatchewan	926,242
Alberta	1,627,874
British Columbia Colombie-Britannique	2,184,621
Yukon	18,388
Northwest Territories Territoires du Nord-Ouest	34,807

Source: Statistics Canada, Advance Federal Electoral District Statements, (Ottawa, Queen's Printer, 1971).

Table 18

PRODUCTION OF SOFTWOODS AND HARDWOODS, BY CENSUS GEOGRAPHIC AREAS, 1970

(Millions of board feet, lumber tally)

Census Geographic Area	1970
UNITED STATES	34,417
Eastern United States	14,992
Northeast Region	1,579
New England Division	749
Maine	333
New Hampshire	144
Massachusetts	93
Connecticut	27
Other	152
Middle Atlantic Division	830
New York	276
New Jersey	29
Pennsylvania	525
North Central Region	1,821
East North Central Division	1,210
Ohio	202
Indiana	171
Illinois	144
Michigan	407
Wisconsin	286
West North Central Division	611
South Region	11,592
South Atlantic Division	4,961
Virginia	1,077
West Virginia	432
North Carolina	1,171
South Carolina	715
Georgia	1,090
Florida	344
Other	132
East South Central Division	3,432
Kentucky	493
Tennessee	547
Alabama	1,291
Mississippi	1,101

Table 18 (continued)

West South Central Division	3,199
Arkansas	1,311
Louisiana	818
Oklahoma	176
Texas	894
Western United States	19,425
Mountain Division	4,174
Montana	1,294
Idaho	1,641
Wyoming	194
Colorado	274
New Mexico	302
Arizona	327
Utah	67
Nevada	15
South Dakota	60
Pacific Division	15,251
Washington	3,271
Oregon	6,562
California	5,093
Alaska and Hawaii	325

Source: U.S., Department of Commerce, Bureau of the Census, _Lumber Production and Mill Stocks 1970_, Series MA-24T(70)-1, (Washington: U.S. Government Printing Office, 1970).

Table 19

ESTIMATES OF CANADIAN PRIMARY FOREST PRODUCTS BY PROVINCE, 1969

Province	Quantity (Millions of Board Feet)
Newfoundland	999
Prince Edward Island	68
Nova Scotia	1,455
New Brunswick	2,837
Quebec	12,721
Ontario	7,460
Manitoba	635
Saskatchewan	986
Alberta	1,749
British Columbia	
1) interior	10,748
2) coast	11,933
3) Total	22,681

Source: Statistics Canada, Estimate of Canadian Primary Forest Products By Province, 1969, (Ottawa: Queen's Printer, 1969).

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

There are many variables which affect the location of a charcoal briquette plant; type of production process, size of plant, competition from other producers, transportation cost, source of raw materials, and source of demand.

Due to the competitiveness of the market and brand name attachments that people may have, it is essential for a potential producer to take as much advantage of these variables as he possibly can. Thereby, all costs included, he may be able to sell his product in a given market area at a lower price than his competitors.

The British Columbia Research Council has patented a process, for the production of charcoal, which appears to be superior to any of the other existing processes. It was shown in the chapter on costs of production, situation D, that for a two ton per hour plant, the B.C.R.C. process, operated 8,000 hours a year, could produce at a total cost per ton of $42.16. On the other hand an existing competitor, situation C, operating 7,200 hours a year produces at a much higher total cost of $64.63 per ton. Since the B.C.R.C. process is not in existence the figure of $42.16 could be an underestimate. If the calculation were based on the same number of operating hours per year, the differences in total cost per ton between the two processes would become smaller. In any case it is likely that these will

remain a significant difference in the production costs.

By increasing the output capacity of a plant, economies of scale can be achieved. Situation D shows total costs per ton at: $55.91; $42.16, and $39.87 for one; two, and three ton per hour plants respectively. Building a three ton per hour plant in most areas that are now deficient in charcoal production might be very risky. The larger the plant you build the further away from the plant you have to go to distribute your product. With only a difference of $2.29 in total cost per ton between a two and three ton per hour plant, the distance to market would not have to be great before transportation costs nullified this slight economy of scale. Between a one and two ton per hour plant there is a substantial difference of $13.75 in total cost per ton. Most market areas, deficient in charcoal production, could probably accommodate a two ton per hour plant such that transportation costs to distribute the product would be less than the advantage gained through economies of scale.

Since the raw material is a waste product that causes disposal problems, the producer could assure himself of a free source of wood wastes. By locating at that source of raw material rather than at the market minimizes transportation costs, since the production process is weight losing.

There are several areas in North America that are at present deficient in charcoal production. Many of these have a market large enough to consume the output of a two ton per hour plant. If a prospective producer can find an adequate

source of raw material so that his plant is nearer the market area than his competitors, he may be able to gain an additional freight advantage.

If a producer takes account of these locational factors he should be able to sell his product to brokers and wholesalers at a lower price (C.I.F.) than his competitors. This lower selling price should ensure sufficient demand to sell all of his product.

Canadian Policy Implications

The analysis demonstrated that due to climatic conditions and the vastness of the country combined with a relatively small population density, there are few concentrated market areas of sufficient size to consume the total output of a plant in Canada. The only two possible locations are in South Central British Columbia and in the south of Ontario and Quebec, close to their common border. To minimize risk these plants should locate close to the U.S. border in order to take advantage of nearby export markets. However, there are more attractive locations in the United States that would discourage a prospective manufacturer from locating in Canada. Substantial government incentives would have to be provided for a manufacturer to select a Canadian location.

Since the present Canadian manufacturers ship their product to nearby United States markets, tariff free, for consumption or further processing, the tariff on imports into Canada does not serve to protect them. This tariff only serves to raise the price to the Canadian consumer. Until such time

as there is a Canadian charcoal industry to protect, the tariff should be removed.

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